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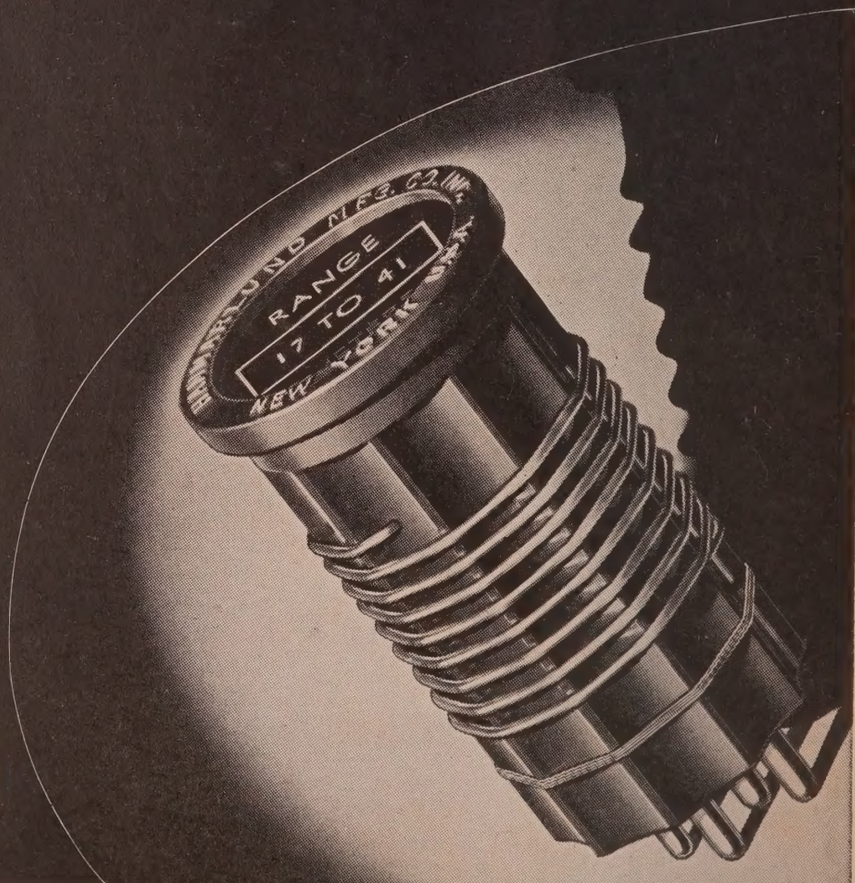

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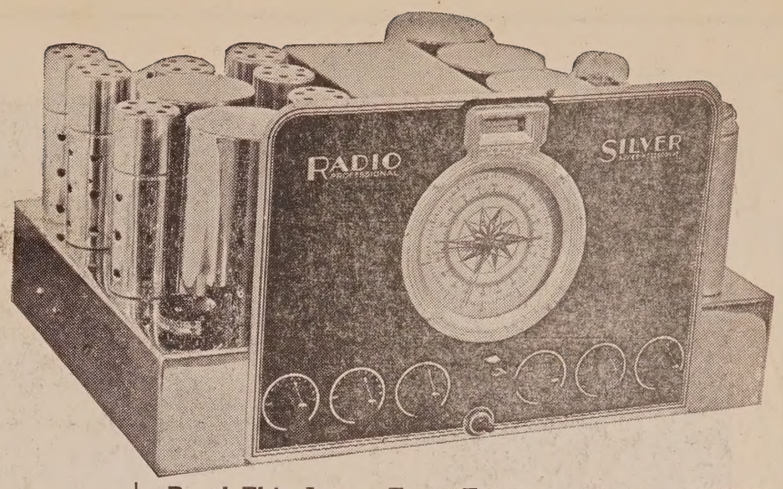

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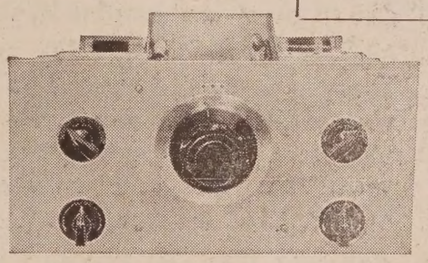

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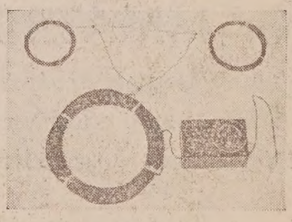

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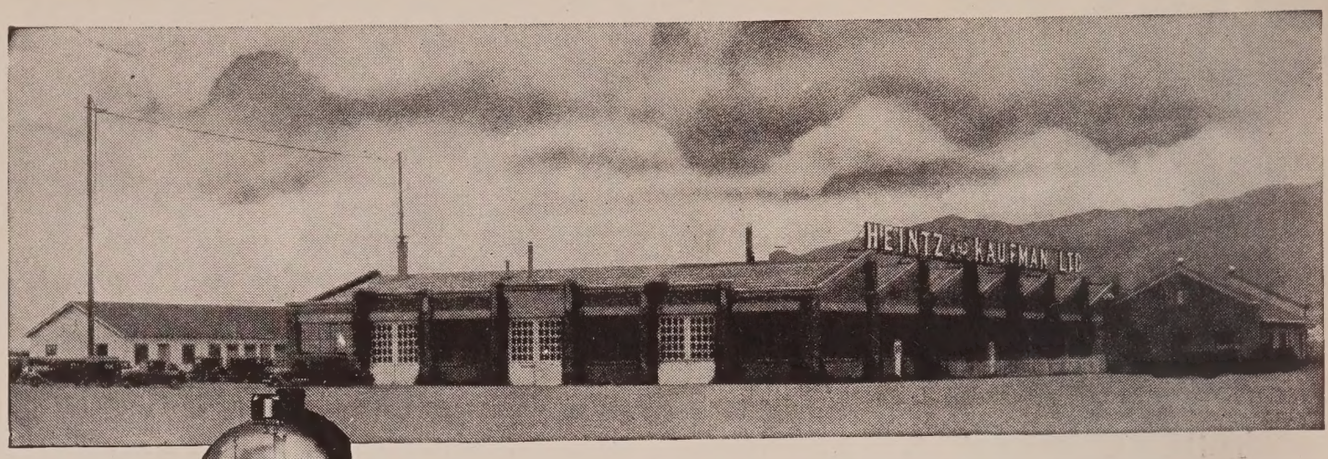

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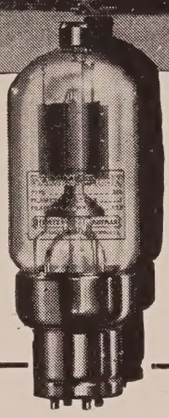

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No. 204 January, 1936

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We're proud to present this, the first issue of the new, merged "RADIO", and hope you like it.

The new "RADIO" retains the entire technical and editorial staffs of both its predecessors, though in this first merged issue "R/9" writers are largely represented alone, due to mechanical difficulties which prevented former "RADIO" material from being changed to the new "RADIO" format on short notice.

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We want to make, we are determined to make "RADIO" what the intelligent radioman wants it. Constructive criticism is always welcome. Even though time may prevent individual replies we want to hear from our readers.

"RADIO" never has been nor will it be edited and printed "down to a price"; deliberately "RADIO" it is "built" to a standard, with price secondary. The single copy will be 30c, and well worth it, we believe.

The new "RADIO" will be issued ten times per year including a special annual issue and omitting the two summer issues when most of us are least interested in radio. But you will not lose thereby, for a full year's worth of information and news is crammed into these ten issues at $2.50 the year, or $4.00 for 2 years. All subscriptions received hereafter will be entered on a ten-issue-per-year basis. All those who have heretofore subscribed will receive the full twelve issues to which they were entitled under the then prevailing rates. Those who were on the subscription rolls of both "RADIO" and "R/9" will have their subscriptions extended proportionately.

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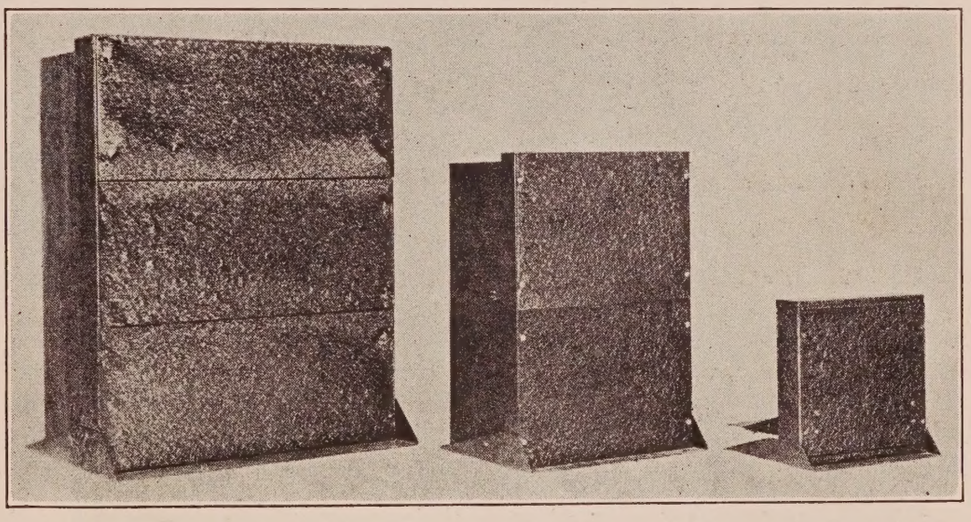

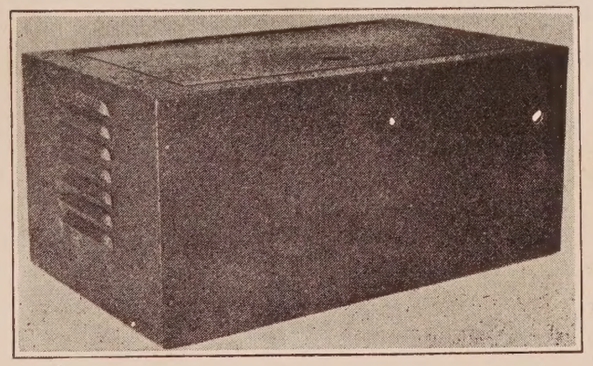

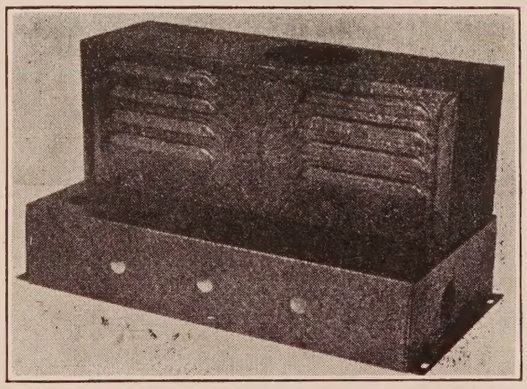

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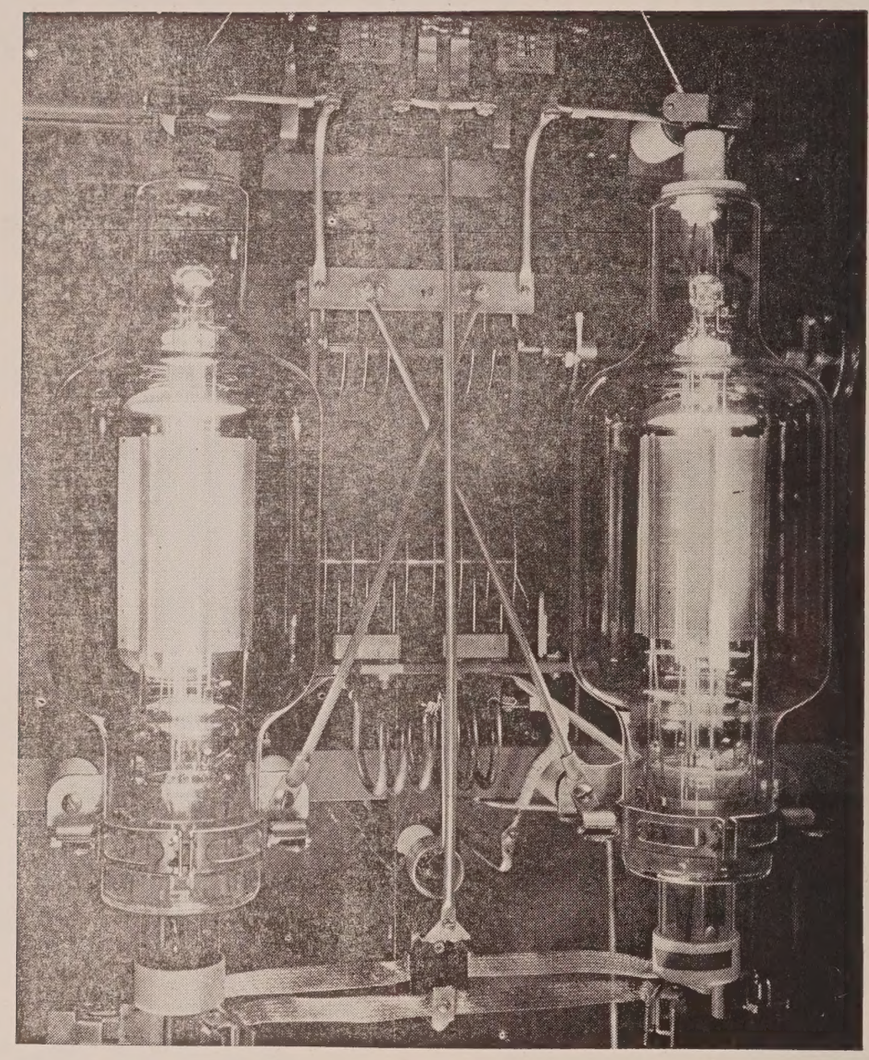

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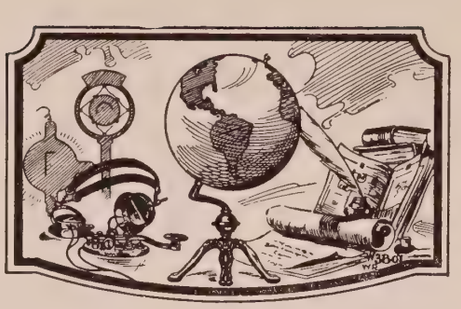
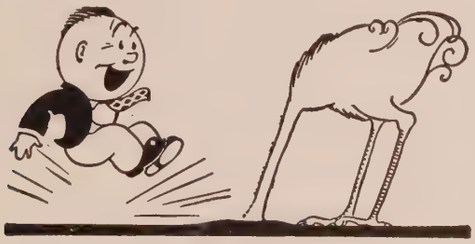


Survey

Word reaches us indirectly that the members of the Cairo Committee of the A.R.R.L.'s Board of Directors have complained of the lack of individual response in its survey to determine the occupancy of certain frequency territories adjacent to our 3.5 and 7 mc. bands. This survey and its purposes were explained in *QST*; data may be had, if one insists, from the A.R.R.L., West Hartford, Connecticut.

We suspect the reason is just the usual amateur apathy—apathy that continues until it is



too late, when our apathetic amateur suddenly wants to know why someone didn't do something about it, not himself, of course, but someone else.

But perhaps we're wrong. Perhaps some amateurs have been using a bit of horse-sense, and realize that such a procedure is loaded with dynamite, for, if the survey discloses no gaps nor any frequencies to which the displaced stations might be moved, we have furnished our opponents with a mighty fine weapon with which to fight us! According to our no-doubt-peculiar notions the proper amount of worrying to do relative to the stations which would be displaced is just about the same amount as they did for us at Washington in 1927—and no more.

Knuckling Under

Dr. Irvin Stewart, Chairman of the Telegraph Division of the Federal Communications Commission, is quoted in recent releases as having spoken at a meeting of the Washington Radio Club as follows:

"I came here tonight to say one thing, and when I have said it I am through. It is this: in your preparations for the Cairo Conference, keep your feet on the ground.

"You can be proud of the fact that of approximately 60,000 amateurs in the world some 45,000 of them are in the United States. You must recognize, however, that these figures furnish the source of your greatest weakness in an international conference. Aside from the United States and certain parts of the British Empire, only one country* has as many as a thousand amateurs. Bands that to you mean traffic congestion, to some countries represent waste space. Far from wanting to set aside more space for amateurs, many countries may feel that too much space is now set aside for them. After all, if space is needed for some service deemed nationally more important, what is more logical than for a delegation to insist that it be made at the expense of that service which is deemed nationally of less importance?

"It is no news to you that frequency allocations must be determined by international agreement. It is no news to you that some countries endeavor to suppress amateurs, that many countries merely endure amateurs, and that only a few countries actively encourage amateurs.

"The moral? Simply this: at Cairo no important delegation will go further for amateurs than the American delegation, and many will be reluctant to go as far. . . .

"If you try to go further than the American position, you may lose part of what you have. If you work with the American delegation, there is a fair chance that the American position may be adopted internationally."

There can be but little question that Dr. Stewart's attitude is a common one; it is based upon the fact that at one of these international dogfights euphemistically called "conventions" each nation has one vote and only one vote. Yes, the little nation with 10,000 population, no broadcasting stations, one commercial station, and two amateurs has an equal "vote" with the United States.

The United States never having been under any obligation to do as other nations wished it to do, why start now? Why should the countries supporting amateur radio allow themselves to be overruled by a group of nations which, though larger numerically, have not as many stations altogether in the high-frequency spectrum as the United States alone has amateurs?

It is high time the United States reasserted its independence of foreign entanglements, an attitude first advocated by Washington, but one

[*Continued on Page 98*]

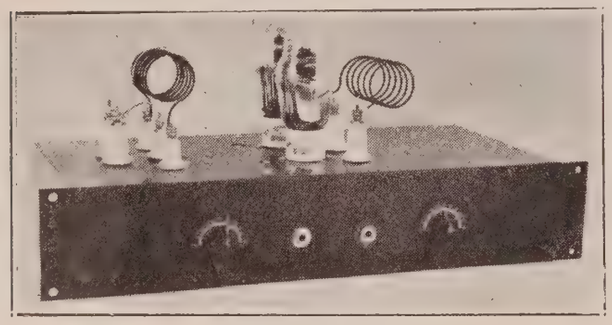
*Argentina.

A De luxe 50 Watt All Band Transmitter

By Ralph O. Gordon, W6CLH

50 to 60 watts output on all bands down to and including 5 meters! Only 4 inexpensive tubes, and no complicated circuits. This transmitter can be described as nearly "ultimate" for those planning 01's in the output stage. The excitation is sufficient for plate modulation on all phone bands; in an early issue there will be described a companion unit for providing 100%, low-distortion plate modulation.

Previous to the production of power amplifier pentodes that actually produce power gain at 60 mc., crystal control on five meters required a multiplicity of doubler stages, with the last stage (in this case, the 10 to 5 meter doubler) operating with a power input far in excess of that applied to the final amplifier. The reason for this was that the last



48 watts output on 5 meters, besides doing its stuff on all lower frequency bands.

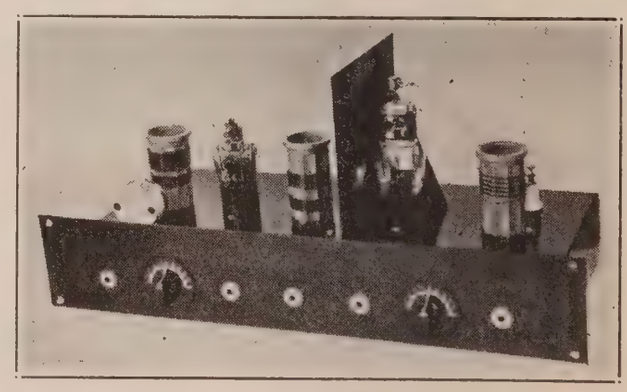
doubler had to deliver sufficient excitation to drive a Class "C" stage, which does not produce much power gain. The efficiency of a frequency multiplier is quite low even at comparatively low frequencies, and when we attempt to multiply to a frequency of 60 mc., extremely low outputs are obtained. The efficiency of a doubler is much greater than that of a tripler or a frequency multiplier producing any of the higher harmonics, and for that reason a series of doublers will produce a greater output than if a single multiplier were used to produce the fourth or eighth harmonic.

However, now that we have tubes that will produce considerable power gain at very high frequencies, and with extremely low excitation requirements, the transmitter can be almost as simple as one for the longer waves. The Type 802 power amplifier pentode will deliver 15 watts output at frequencies up to 30 mc. with but ¼ watt excitation, working as a class "C" amplifier, and will deliver sufficient excitation to drive a pair of 801's even at 60 mc. This means that very little output is required of the multiplier stage.

The efficiency of a frequency multiplier can be improved considerably by the use of the proper type of regeneration. Any feedback system employed must discriminate against the predominating fundamental frequency component of the plate current, so that the feed-back will occur largely at the harmonic frequency. The grid circuit must have a sufficiently high impedance to the harmonic frequency that the feedback energy is not lost completely. Also the harmonic output of the crystal tank must be kept low by the use of a high "C" crystal tank circuit.

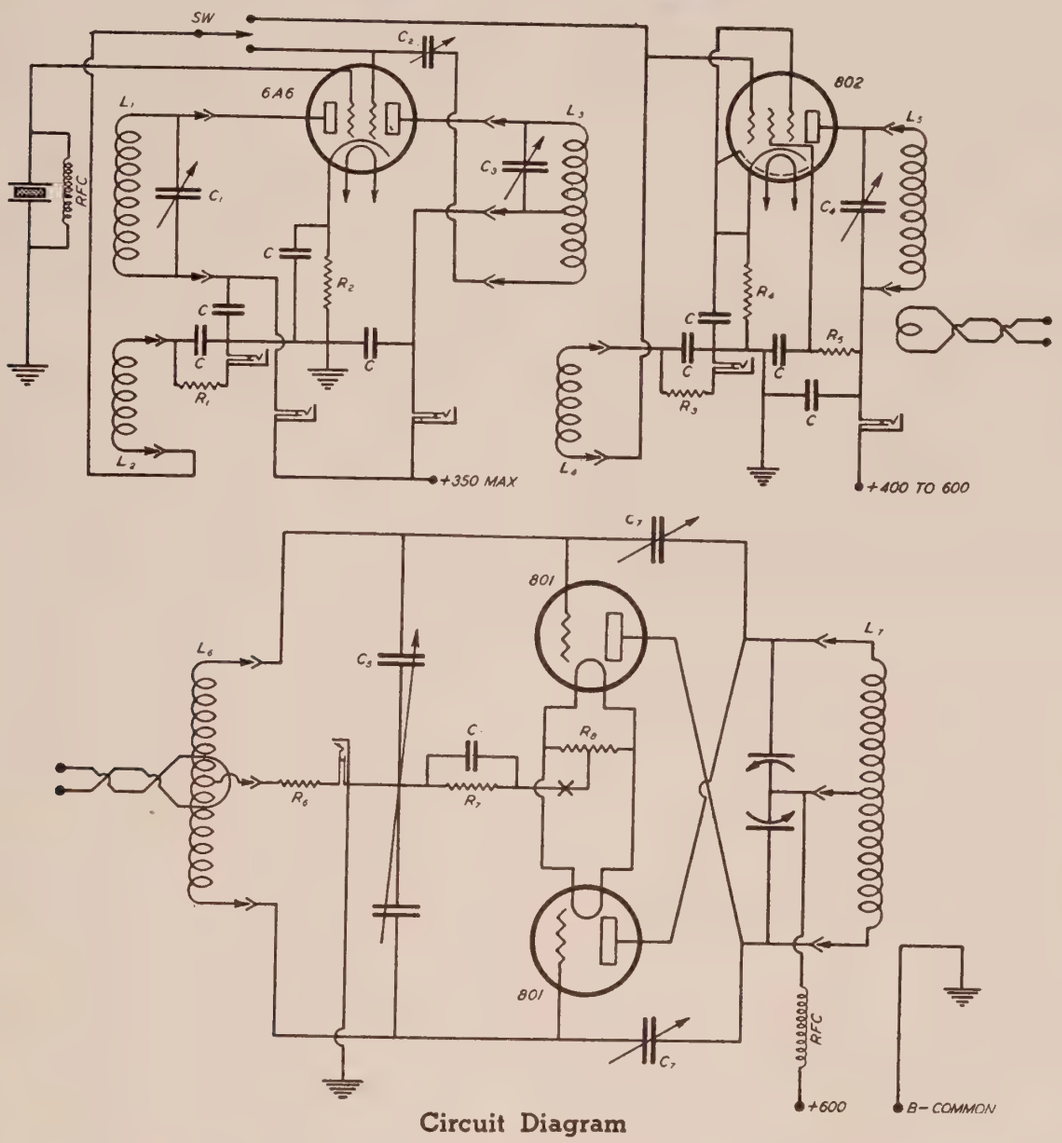
The transmitter described uses a 6A6 for the crystal and multiplier stages and an 802 for a buffer-amplifier on all frequencies. The final amplifier stage uses a pair of 801's in push-pull. The cuts show the construction; two 8" x 17" chassis with 3½" x 19" panels to fit a standard relay rack are used to mount the equipment.

On the exciter unit the tuning control on the left is the feedback control and the one on the right is the plate tank of the 802. The five jacks are from left to right: crystal plate current, multiplier grid current, multiplier plate current, amplifier grid current, and amplifier



The exciter unit, though having but two tubes, really "pushes" the 801's on all bands down to 5 meters.

plate current. On the final unit the controls are grid tank condenser and grid current jack on the left, and plate tank condenser and plate current jack on the right. The neutralizing condensers are mounted vertically and can be adjusted with a screw-driver from the top of



Circuit Diagram

L_1—Crystal tank coil
L_2—Multiplier grid coil
L_3—Multiplier plate coil
L_4—Amplifier grid coil
L_5—Amplifier plate coil
L_6—Final amplifier grid coil
L_7—Final amplifier plate coil
RFC—Sectional-wound r.f. chokes
C—.01 μfd. 1000 volt test mica condensers
C_1—Crystal tank condenser, 100 μμfd.
C_2—Feedback condenser, 35 μμfd.
C_3—Multiplier plate tank, 25 μμfd.
C_4—Amplifier plate tank, 20 μμfd. double spaced
C_5—Final grid tank, split-stator, 35 μμfd. per section
C_6—Final plate tank, split-stator, 100 μμfd. per section
C_7—Neutralizing condensers, 12 μμfd. double spaced
R_1—20,000 ohm 10 watt wire wound
R_2—400 ohm 10 watt wire wound
R_3—20,000 ohm 10 watt wire wound
R_4—500 ohm 10 watt wire wound
R_5—20,000 ohm 10 watt wire wound
R_6—5,000 ohm 10 watt wire wound
R_7—500 ohm 10 watt wire wound
R_8—50 ohm center tapped

the chassis. The crystal and multiplier plate tank condensers are mounted inside the coils and do not have to be disturbed when changing from one band to another. The coils on the exciter unit are all wound on Hammarlund forms, which have provision for mounting the condenser inside. The final amplifier coils are self-supporting except for the 160 and 80 meter bands, which can be wound on forms with G.R. plugs attached to them so that they will plug into the jacks in the end of the stand-off insulators. A single turn at each end of a twisted pair link couples the 802 to the 801's.

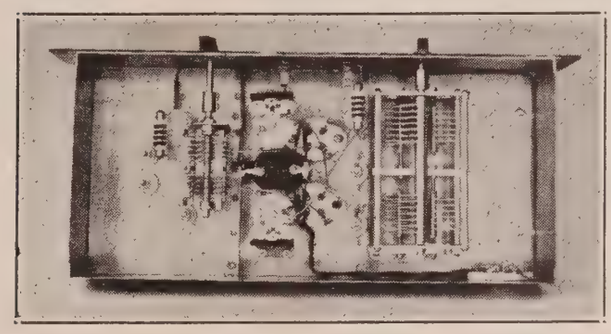
Coils

The three plug-in coils in the exciter unit are wound on 1½" diameter coil forms with all windings wound in the same direction. The plate terminal should be at the top of the form and the grid at the bottom as shown in the circuit diagram. When winding the coils put on a few extra turns on the grid coils and then remove one turn at a time until the greatest amount of grid current is obtained. The number of turns given in the coil data was found to be the best for the arrangement of parts shown, but different condensers and other po-

sitions of the wiring would require a change in the number of turns in the coils. The difference would be slight however.

Circuit Details

The first half of the 6A6 operates as an ordinary crystal oscillator and gets its bias from



Bottom view of the final amplifier.

the voltage drop in the 400 ohm resistor in the cathode circuit. The other half of the 6A6 acts as the multiplier and gets its bias partly from the cathode resistor and also from the resistor in its grid return, which has a voltage drop due to the rectified grid current caused by excitation from the crystal stage. This method of obtaining bias is used on all the stages and is very desirable. The resistors in the cathodes are just high enough in value to protect the tubes in case of failure of excitation but not so large as to sacrifice much plate voltage. The greater portion of the grid bias voltage is obtained from a grid leak in each case.

When it is desired to operate at crystal frequency the 2d coil is not plugged in its socket. This leaves the second half of the 6A6 idle as it has no plate voltage. In this case a switch should be provided to connect the grid of the 802 direct to the grid coil wound on the crystal tank form.

The grid terminal of the 802 comes out of the socket and is shielded from the plate tank condenser by a partition in the bottom of the chassis between the socket and the condenser, while the plate of the tube, the terminal of which comes out the top, is shielded from the grid coil by a baffle plate a little higher than the tube. These shields are necessary to prevent the 802 from self-oscillating at the higher frequencies. When hooking up the socket of the 802 be sure and notice that the terminal marking given in the dope sheet is looking at the top of the tube and *not* the bottom, the latter being usual in most diagrams. We made the mistake and thought the tube was no good; it would pull only about 10 ma. with 500 volts and no bias.

The final amplifier is quite ordinary and does not have to be neutralized but once; coil changes do not affect neutralization. If the transmitter is to be used for phone, the .01 μfd. condenser across R_7 should be paralleled with a 10 μfd. 200 volt electrolytic condenser to bypass the speech frequencies. For c.w. the final can be keyed in the center tap marked "X" in the circuit diagram.

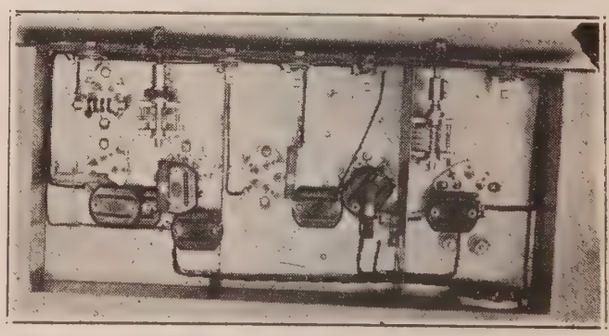
The jacks shown in all the circuits are quite necessary to get the set in operation.

Operation

The initial adjustments of the coils and condensers are quite critical, but when once made it is very simple to change bands. For 160 or 80 meters a 160 meter crystal should be used. For 40, 20, 10, or 5 meters a 40 meter crystal should be used. The power supplies should deliver 350 volts for the 6A6, and 600 volts on the 802 and the 801's for frequencies up to 30 mc. For frequencies up to 60 mc. the voltage on the 802 should be reduced to about 400 volts.

With a milliammeter in the plate jack of the crystal tube and another meter in the grid of the multiplier, apply voltage to the plate of the crystal tube *only*. If the crystal is not oscillating, the plate current will be about 10 ma. and about 20 ma. when the maximum grid current is obtained in the multiplier (crystal oscillating). With a good 40 meter crystal the multiplier grid current should be 5 to 8 ma.

If the adjustments are to be made for 80, 20, 10, or 5 meters, apply voltage to the plate



Bottom view of the exciter unit. Note that the plate circuit of the 802 is shielded from its grid circuit below the sub-panel as well as above it.

of the multiplier section of the 6A6 *only*. With the feedback condenser at zero or minimum capacity the plate current should be 10 ma. and the grid current zero on the multiplier and the 802. Increase the capacity of the feedback condenser until the plate current drops and grid current appears on both the multiplier and the 802. This shows that the multiplier is self-oscillating. The heater of the 802 must

Coil Data

		160 m.	*80 m.*	*40 m.*	*20 m.*	*10 m.*	*5 m.*
Oscillator L1	Number of turns	50	29	16			
	Wire size no.	26	22	18			
	Spacing of turns	None	None	None			
	Space between L1 and L2 (in.)	.25	.3	.4			
Multiplier Grid L2	Number of turns	65	35	18			
	Wire size	28	26	24			
	Spacing of turns	None	None	None			
Multiplier Plate L3	Number of turns		33		13	7	4
	Tap from top of coil		18		7	4	2½
	Wire size		18		18	18	14
	Spacing of turns		None		Diam. of wire		
	Space between L3 and L4		.25		.3	.4	.5
Amplifier Grid L4	Number of turns	60	32	17	14	8	5
	Wire size	28	26	24	20	18	14
	Space between turns	None	None	None	Diam. of wire		
Amplifier Plate L5	Number of turns	55	32	18	13	7	4
	Wire size	26	20	18	18	14	14
	Space between turns	None	None	Diam. of wire			
Final Grid L6	Number of turns	65	35	18	14	7	4
	Wire size	18	18	14	14	14	14
Final Plate L7	Space between turns	Coils wound to fit jacks Self-supporting except 160 and 80 which are wound on forms					

be hot for grid current to flow. The best setting of the feedback condenser is for very feeble oscillation in the multiplier. Now apply voltage to both sections of the 6A6 and adjust the plate tank condenser of the multiplier for highest grid current on the 802. When multiplying to the fourth or eighth harmonic no dip in plate current is noticed without feedback on the multiplier, but with the proper amount of feedback the plate current will dip at resonance similar to a straight amplifier. The ideal condition of multiplier action is such that when the crystal is removed the multiplier will continue to oscillate, but if the power is shut off, the multiplier will not start when the power is again applied with the crystal out. A monitor or a receiver should be used to check the signal while making these adjustment to detect self-oscillation in the multiplier at some frequency near the harmonic.

The plate current of the multiplier should not be allowed to run above 35 ma. as the tube can't stand it. With insufficient feedback the plate current will be higher and will gradually creep up until the plate gets red hot. Much abuse like that and you put in a new 6A6. The grid current on the 802 should be about 8 on 20 meters, 4 on 10, and 1 to 2 on five meters. 2 ma. is all that is necessary to give full output of 15 watts. Next apply the plate voltage to the 802 and, with the excitation on, tune the plate tank condenser for the dip. The plate current should dip to about 30 to 35 ma. and go up to 70 or 80 out of resonance. Connect the link to the coils, light the 801's, and tune the grid tank condenser on the 801's for maximum grid current. Adjust the link by sliding it up or down on the 802 tank coil until the grid current on the final is the highest consistent with safe plate current on the 802, which should be not more than 60 ma. total for plate and screen at that plate voltage.

To neutralize the final, tune the plate tank condenser through resonance until the grid current takes a sudden jump, and then adjust the neutralizing condensers (keeping them both at the same capacity) until the grid current does not change while tuning the plate tank condenser through resonance. All that is left to do is to apply the voltage to the 801's and tune the plate tank condenser to the dip. When using cathode bias the plate current dip is not as pronounced as when fixed bias is used due to the bias reduction with reduced plate current.

In a following article an economical modulator and speech amplifier will be described.

A 150 Watt, Three Band C.W. Transmitter

By Jayenay

Here is an adaptation of the W6BHO exciter, described last month, to an economical 20, 40, and 80 meter c.w. rig. It puts out between 150 and 200 watts, depending upon frequency. Dollar for dollar, it is hard to beat.

Exceptionally good results are obtainable with a properly excited 211 running at around 1500 volts on the plate. The 211 happens to be the easiest tube of its size to excite, so it was chosen for this transmitter over the 838 or the 203A types. The 211 runs at 1500 volts and 150 ma., which is a d.c. plate input of 225 watts. The output was somewhat more than 150 watts on 20 meters and 175 watts on 40 and 80 meters, indicating a satisfactorily high plate efficiency.

The circuit is straightforward and conventional in most respects.

The Exciter

The exciter consists of a 42 driving paralleled 42's. On 40 and 20 meters the first 42 is the crystal oscillator and the paralleled 42's act as frequency doublers. On 80 meters the first 42 is not used and the paralleled 42's act as the crystal oscillator. In other words, the rig uses three stages on 40 and 20 but only two stages on 80. Of course, a 40 meter crystal could be used at X_2 in the grid circuit of the paralleled 42's in order to drive the final on 40 meters, but it was found that more excitation and output was obtained on 40 meters by using an 80 meter crystal and doubling once rather than going straight through on 40.

Capacitative coupling is used between the first and second stages although link coupling gives slightly better results at this point. However, it was not felt that the additional excitation justified the additional cost of the extra coil and tuning condenser. Switches SW_1 and SW_2 can be ganged but it is not essential. Primary keying was used on the final power supply but any other desired keying system could be used with equally good results.

The Final Amplifier

The final amplifier uses grid neutralization, which seems to cause no noticeable degeneration (which robs many plate neutralized amplifiers of some grid excitation). The stage is neutralized by the use of a 0-50 d.c. milliammeter in the d.c. grid return. With full excitation applied to the final amplifier and with the 211 plate voltage turned off, the neutralizing condenser is varied until tuning the plate tank tuning condenser through resonance causes absolutely no change in the d.c. grid current.

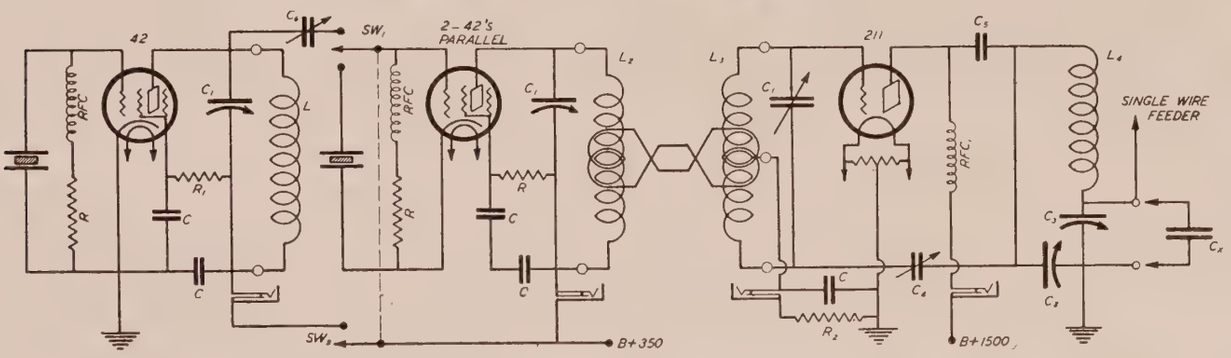
Without plate voltage the d.c. grid current is about 30 ma. on 20 meters and 35 to 45 ma. on 40 and 80 meters. When the plate voltage is applied to the final stage and the antenna is coupled up, the d.c. grid current drops about 10 to 15%. Without the antenna coupled to the tank, the minimum plate current is 15 ma. on all bands and the antenna is coupled up until the plate current is 150 ma. on all bands at resonance. Out of resonance the plate current swings up close to 450 ma.

The antenna coupling system shown is highly desirable for use with either a quarter wave Hertz (Marconi) or a single wire feed type of antenna. The coupling to the antenna is varied with the 200 μμfd. antenna condenser, after every adjustment of which tank circuit resonance is restored by means of the 50 μμfd. tank tuning condenser. With some types of antennas it will be found that the 200 μμfds. in the antenna coupling condenser are not enough to get the plate current down to 150 ma. In this event it will be necessary to shunt a 0.00025 μfd. fixed mica condenser across the antenna coupling condenser. At low plate voltages this will not be necessary. For any given antenna, the lower the capacity of the antenna tuning condenser, the greater will be the antenna loading and the higher will be the plate current to the 211. The general rule for tuning this transmitter is to tune each plate circuit for minimum plate current and the grid circuit of the 211 for maximum grid current. The coupling link between the paralleled 42's and the 211 grid circuit should be adjusted for maximum 211

COIL TABLE

Band	X_1	X_2	L_1	L_2L_3	L_4
80		80	80	80	80
40	80		80	40	40
20	40		40	20	20

Band	$L_1L_2L_3$	L_4
80	41 turns no. 22 d.c.c.	26 turns no. 12
40	21 on 1½ inch iso-	12 space wound
20	10 lantite	5 2½ in. diam.



The wiring diagram of the 150 watt 20, 40, and 80 meter c.w. transmitter.

R—15,000 ohms, 3 watt, carbon.
R_1—30,000 ohms, 3 watts.
R_2—7,500 ohms, 25 watts.
C—.004 µfd. mica 1000 volts.
C_1—50 µµfd. midgets.
C_2—100 µµfd. 4000 volt spacing.
C_3—200 µµfd. 1000 volt spacing.
C_x—250 µµfd. 5000 volt fixed mica.
C_4—15 µµfd. 4000 volt spacing.
C_5—.002 µfd. 5000 volt, mica.
C_6—25 µµfd. midget.
RFC—receiving type short wave chokes.
RFC_1—Transmitting type r.f. choke, 200 ma. or larger.

grid current up to the point where the plate current on the paralleled 42's goes above 75 ma. The 25 µµfd. coupling condenser between the 42 stages should be adjusted until the oscillator oscillates easily yet draws from 30 to 40 ma. of plate current on the 80 meter crystal and about 25 ma. on the 40 meter crystal. When working on 80 meters and using the paralleled 42's as the crystal oscillator the plate current for that stage will be about 65 ma.

This transmitter is capable of exceptionally good results and will be only about one R weaker than a kilowatt rig at any receiving point, assuming equivalent antennas for each rig.

This whole rig, including power supplies, can be built for less than a dollar a watt of output.

◆

Did you ever hear of a broadcast station calling "CQ amateur stations"? Such was the case during the recent Miami hurricane when an unidentified freighter was in distress about a mile offshore. A general call was issued from a b.c. station to amateurs in that area requesting that the position and plight of the freighter be relayed to Coast Guard headquarters in Fort Lauderdale. The alarm was picked up by a local amateur and relayed to the Coast Guard promptly, and a cutter was dispatched to the aid of the floundering ship. The broadcast stations in Miami, incidentally, were running on emergency power supplies and with temporary antennas.

◆

The *Chicago Daily News* once employed a special stenographer to take messages to be relayed by Chicago hams. About the same time, the *St. Paul Dispatch-Pioneer* printed and distributed special radiogram blanks to help local hams round up traffic.

FRENCH PREFIXES

The *Réseau des Emetteurs Francais* announces that the new prefixes for amateur radio stations in French territory have been established by the French government as follows:

F, F8—France
FA3, FA8—Algeria
FB8—Madagascar
FD8—Togoland
FE8—Cameroons
FF8—French West Africa
FG8—Guadeloupe
FI8—French Indo-China
FK8—New Caledonia
FL8—French Somaliland
FM8—Martinique
FN8—French India
FO8—French Oceania
FP8—Saint Pierre and Miquelon
FQ8—French Equatorial Africa
FR8—Reunion Island
FT4—Tunis
FU8—New Hebrides
FY8—French Guiana
CN8—Morocco

◆

It seems we have no monopoly on phoney phones. A correspondent (VK3CD) in *Amateur Radio* (Australia) complains about the "ghastly doggerel" from many phone stations, including such expressions as "the personality station," "the voice of the radiant operator," and the like.

◆

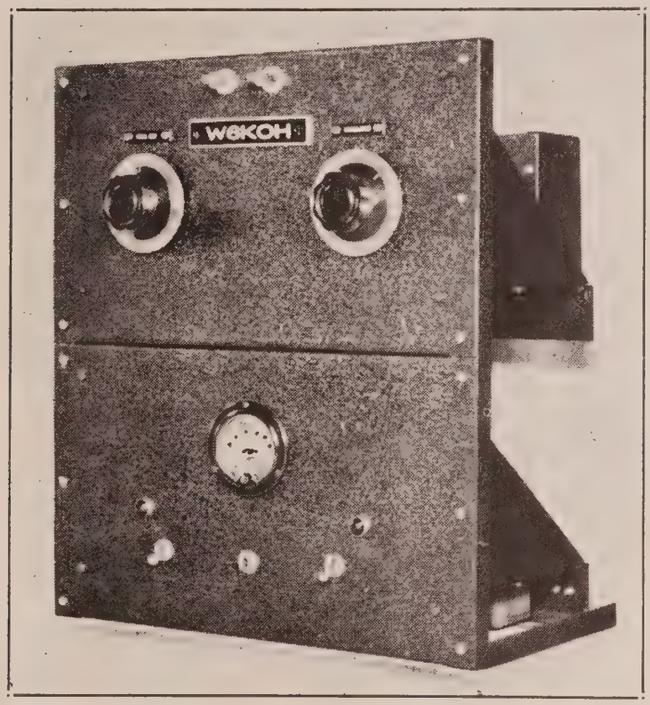
WAVE is a broadcast station in Louisville; WACO in Waco, Tex.; WELL, appropriately enough, is located in the same town with a world-famous sanitarium. WICC and W1CC are both in New England. WALA, KWYO, WILL, and WIND are located in the states whose names are abbreviated by their calls.

Modulated Watts in a Nutshell

By W. W. Smith, W6BCX

How many times have you wished that you could pull a plug or two, disconnect the antenna, and haul your transmitter (or at least enough of it to put a respectable signal on the air) off to your summer cottage or with you on a trip? You can; all you have to do is lay your transmitter out that way when you build it.

Despite the fact that it takes a little more time to build a transmitter in one or more units that may easily be carried from place to place than it does to spread parts all over the side of a room and tie them together with magnet wire, the advantages of owning a transmitter of the former type make the additional work



The "full-grown" midget transportable transmitter. The two feed-through insulators at the top of the front panel connect to the antenna coupling link.

of construction really worth while. A transmitter may be made compact without sacrificing any efficiency. By compact is not necessarily meant a jamming of parts, but rather the elimination of needless separation and waste space. If proper precautions are taken there is no reason in the world why r.f., audio, and 60 cycles cannot occupy the same house. Let us cite for example the excellent transmitters of Arthur Collins, which are self-contained in a single rack (except, of course, the highest power ones, which take up considerable room).

The transmitter shown in the photograph, with a carrier power of 20 watts, is entirely self-contained, except for a 4½ volt C battery which provides microphone voltage, in a rack only 16 inches high and 14 inches wide. Thus with a transmitter that may be carried under one arm one may enjoy portable operation with but little more trouble than erecting an antenna. We might dub this little rig "The Traveling Salesman's Special" because of its adaptability to portable operation. Those of you who have never experienced the enjoyment that comes from talking to the gang back home when you are in a strange city have missed one of the biggest "kicks" to be gotten from amateur radio.

As the total drain at the a.c. input terminals is a little less than 100 watts (slightly exceeding 100 watts when swinging the modulators), the transmitter may be operated from one of the new 110 volt a.c. generators now available for operation from the fan belt of your auto, thus permitting true portable operation. The enjoyment received from talking from your hotel to the gang at home can be even surpassed by the pleasure received from working the home folks when you are "roughing it" on a hunting or fishing trip and are miles from the nearest power.

The transmitter consists of a 41 pentode operating at 350 volts driving an 802 which is simultaneously plate-and-screen modulated on either 75 or 160 meters. The speech consists of a high quality single-button microphone (the good ones sound better than many of the cheaper two-button microphones) working directly into a 53 speech amplifier-driver which is coupled through a stepdown driver transformer to the grids of a pair of 46's in class B, which in turn plate-and-screen modulate the 802, which runs at 500 volts and about 55 or 60 plate ma.

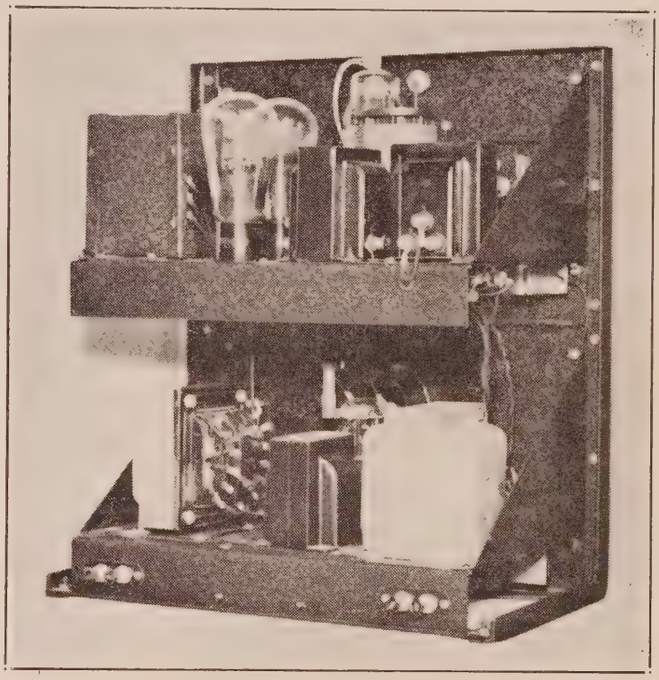
The 802 was chosen for this particular job rather than a triode because the screen grid feature makes it possible to dispense with neutralizing and, due to the low excitation requirement, permits very light loading of the oscillator. This is necessary in order to insure freedom from frequency modulation, because no buffer stage is used. With light loading of the oscillator and the oscillator plate tank detuned

from maximum output (both contributing to stabilization of the oscillator frequency) there is plenty of drive on the grid of the 802 fully to excite it even when high-level modulated. The only disadvantage of the 802 as compared to a triode in this position is that approximately half again as much audio is required to modulate it to the same modulation percentage of a given carrier output because of the audio "wasted" by the screen and its associated voltage-dropping resistor. That is why 46's were chosen as modulators rather than a tube or tubes of less audio output. Besides this, the 46's require no bias, and they take the full 500 volts from the single power pack which supplies the whole transmitter. No dropping resistor is required to the modulators; hence there is no waste of input power on that score. Voltage-dropping resistors are used on the 53 and on the oscillator tube, but these tubes pull very little current and not much power is wasted.

A single power supply for the whole transmitter greatly simplifies construction and is more economical than two power supplies, both from the standpoint of cost and space required. However, because of the swinging current of the 46's, excellent voltage regulation is necessary or the voltage on the radio frequency portion of the transmitter will drop considerably each time one tries to modulate. The 46's swing from about 20 ma. resting to around 80 ma. on voice peaks, a difference of 60 ma. By using a husky, well-designed plate transformer, a low resistance swinging-choke-input filter and an 83 or 83v as a rectifier tube, sufficiently good regulation will be realized, and the voltage drop under modulation will be barely perceptible and of no detrimental consequence.

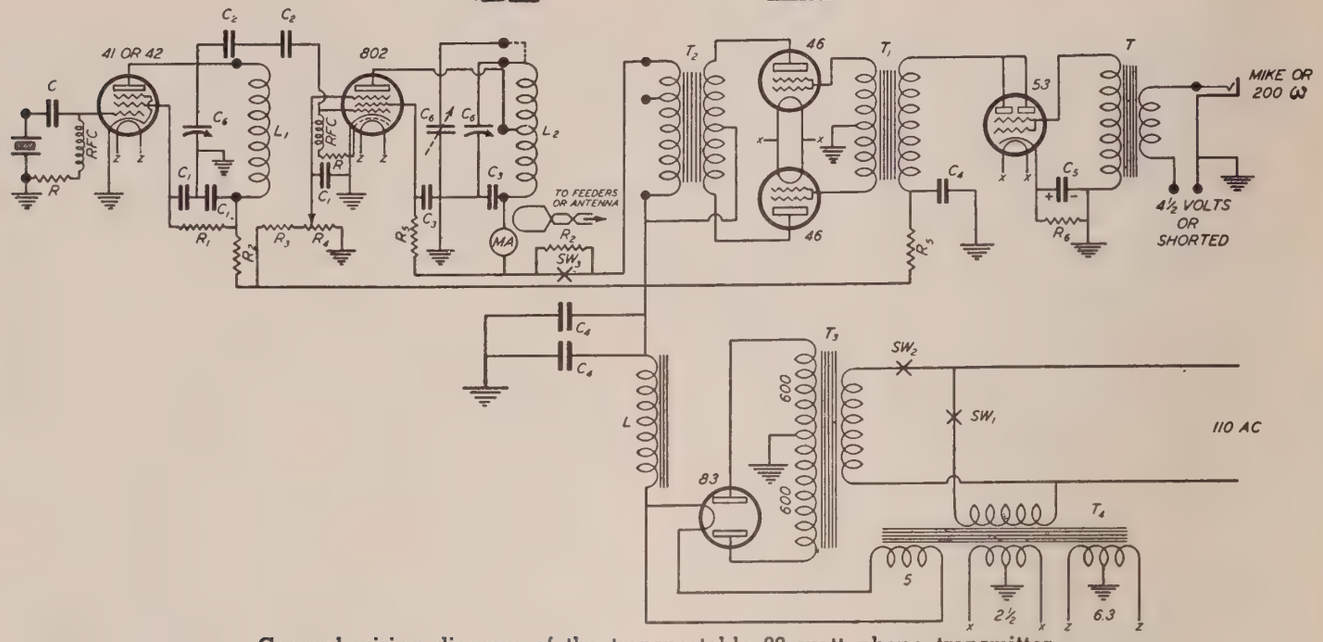
It would at first appear that because very little filter is used on the power supply there must be considerable hum in the carrier. Quite the contrary, the hum level is very low. This probably can be explained for the modulators by the fact that a push-pull stage can digest considerable plate supply hum without any showing in the output. The voltage-dropping resistor to the 53, plus the 8 μfd. bypass condenser "aft" the resistor, make an effective resistance-capacity filter which provides additional filtering to the main power supply filter on the 53 stage. Lack of serious hum from plate supply modulation of the 802 is probably explained by the fact that the secondary of the modulation transformer provides additional filtering to that of the apparently skimpy power supply filter. The 12 μfd. of power-supply filter condenser are used not just to suppress power supply ripple, but also because a very large capacity is required when a power supply feeds both a modulated stage and a class B audio stage. A single filament transformer with several windings supplies filament current to all tubes in the transmitter including the rectifier. Thus the tubes may be allowed to heat before the plate voltage is applied. This is of prime importance when a mercury vapor 83 rectifier is used.

A good single-button microphone permits highly intelligible speech, and, except for the



The r.f. and speech systems are located on the top deck, and the power supply is located on the bottom deck. Filter condensers are fixed to the under side of the bottom shelf. Because of the high level of the speech input, and because of the comparatively low power of the r.f. portion, no trouble is experienced from r.f. pickup in the speech circuits, in spite of the fact that r.f. and speech components are quite close together. The oscillator coil cannot be seen because of the class B output transformer, but is located behind it at right angles to the ouput tank coil.

fact that it may not sound quite as natural as a better microphone, actually has a big advantage in that it *effectively* multiplies your power by about two. This is so because most of the audio power is confined to the "intelligibility frequencies", and the low bass notes (which add nothing to understandability but eat up great gobs of audio power) are eliminated, thus permitting a higher percentage of modulation without overmodulation, at the voice frequencies which really do some good. If it is desired to use a better microphone, a preamplifier with 200 ohm output may be coupled into the micro-



General wiring diagram of the transportable 20 watt phone transmitter

C—50 μμfd. mica.
C_1—.006 μfd. mica.
C_2C_2—Two 40 μμfd. mica in series (20 μμfd.).
C_3—.002 μfd. mica.
C_4—6 μfd. paper 700 volt peak "8 μfd. electrolytic replacement."
C_4C_4—Same as above except dual unit (12 μfd. total).
C_5—25 μfd. 25 volt electrolytic.
C_6—35 μμfd. double spaced midgets.
L—12-40 hy. 250 ma. swinging choke (not over 100 ohms).
L_1—See coil table.
L_2—See coil table.
R—10,000 ohms, 2 watt carbon.
R_1—75,000 ohms, 2 watt carbon.
R_2—5000 ohms, 10 watts.
R_3—25,000 ohms, 10 watts.
R_4—25,000 ohm slider type resistor.
R_5—20,000 ohms, 10 watts.
R_6—1200 ohms, 2 watts.
T—Microphone transformer (200 ohm input).
T_1—Class B input for class A 46 into Class B 46's or for 53 class A driver to 53 class B.
T_2—Output transformer for class B 46's to 5000 and 10,000 ohms.
T_3—250 ma. power transformer, 600 a.c. volts each side of center tap.
T_4—Filament transformer with 5 volts, 6.3 volts, and 2.5 volts, latter two windings center tapped.
MA—Two inch 0-100 ma. d.c. milliammeter.

phone jack instead of the single-button microphone, and the mike battery terminals shorted. This extra audio equipment would take up considerable room if incorporated in the transmitter proper and would reduce the portability feature of the transmitter. Even if you insist on condenser microphone quality at home, it is pretty hard to argue that the single-button microphone is not the most desirable for portable use, not only because of its higher output, but because of its ruggedness and cheapness. Even if the mike is dropped in the lake or otherwise lost you are not out a whole lot. The gain of the speech system is just about right for the average single-button microphone when a 4½ volt microphone battery is used. For that reason no gain control is incorporated; "the gain" is varied by the simple expedient of talking closer to or farther from the microphone. A distance of about six or eight inches will be found approximately correct for most single-button microphones, excepting of course, for the "bellowing bulls" and the "whispering baritone" amateurs, who will have to adjust the distance to suit.

It is astounding what one can do with 20 watts in a *good* antenna, but if you are not happy without higher power at your home station, a high efficiency (class B prime) linear amplifier may be incorporated as a permanent fixture to the home station along with the high-fidelity mike and preamplifier. Thus without duplicating equipment you may have high power and excellent fidelity at home and at the same time *portability* on the road.

Because each thing seen on the front panel is proportionately small, the photograph showing the front view is somewhat deceiving as to actual size. The meter is one of the new 2-inch bakelite cased types and matches well with the small 2¾-inch dials.

An ordinary receiving type midget condenser with regular spacing was first tried in the 802 tank. However, occasional trouble was experienced from the condenser arcing over on modulation peaks. To avoid this a "double spaced" midget was employed. Actually it has about four times the spacing of the receiving type regular-spaced condenser. As the maximum capacity of these condensers is 35 μμfd. (some makes are available in 50 μμfd.) the plate of the 802 is tapped half way down the coil in order to increase the "Q" of the tank, giving the same effect as a tank circuit with a

considerably higher C/L ratio. On 160 meters the Q even with the tapped coil is not high enough when the 802 stage is loaded to maximum output. Therefore, another double spaced 35 μμfd. midget is mounted behind the front panel and permanently set with the plates all the way in. This lump capacity is shunted across the tuning condenser on the panel when the 160 meter coil is inserted in the coil mounting socket. This is done by jumpering the "hot" prong on the 160 meter coil to one of the dead prongs not used on the 75 meter coil. This lump capacity is connected to the corresponding socket connection so that it comes into play only with the 160 meter coil. This system was used rather than a single large condenser on the panel because the midgets are cheaper (the ones used cost but 60c each) and they take up much less room than a single transmitting type condenser of 75 or 100 μμfd.

The suppressor voltage on the 802 is adjusted to approximately 50 volts positive by varying the slider on the voltage divider. This positive voltage on the suppressor gives a worthwhile increase in efficiency and permits greater output from the 802. The crystal tube runs at about 375 volts. Because it is a pentode, the crystal current is quite low and no apprehension need be felt even with garden variety crystals. If plate voltage is applied to the 802 without grid excitation, or if the 802 is being excited but is off resonance very far, the tube may be permanently damaged from excessive plate current and heating. To avoid this a dropping resistor is employed for tuning up. After the oscillator is adjusted and the amplifier tank is dipped to resonance, the shorting switch may be thrown, cutting out the dropping resistor and applying full plate voltage to the tube. Because of the permanent dropping resistor and because of the low screen voltage on the 41, the oscillator may be kicked out of oscillation and the 41 will not be damaged in the least. The 802 is the only tube that requires watching; if the low voltage switch (Sw_3) is used when tuning up, the 802 should live to a ripe old age. Unless the crystal is a very poor one, there is no danger of failure of excitation to the 802 due to the oscillator either not starting or "kicking out", because the oscillator is very lightly loaded and when once adjusted will always take off without trouble and will go merrily along indefinitely.

It is important that the filter choke in the power supply have very low resistance, not over 100 ohms or so, or the regulation of the power supply will not be sufficiently good to allow operation of class B modulators from the same power supply as the final amplifier.

The two feed-through insulators at the top of the front panel connect to a coupling link around the bottom (cold end) of the 802 tank coil. Thus the transmitter will feed a zepp., a doublet with twisted pair feeders, or a Marconi. The exact number of turns on the link will depend upon which of these antennas is used. To end-feed a half wave antenna (Fuchs) or to feed a single wire transmission line it will be necessary to link couple to an external tank circuit, either the center or one end of which may be grounded and the antenna or feeder tapped on the coil at the proper position (determined by experiment).

COIL TABLE

Oscillator coils are close wound no. 24 enamelled. 802 tank coils are close wound with no. 20 d.c.c., tapped at center turn. 160 meter coil has jumper from "hot" end to plug corresponding to base pin wired to fixed-tune midget behind panel.

Band	Turns or winding length	Form diameter
160 osc.	1⅝" long	1¼" midget form
75 osc.	¾" long	1¼" midget form
160 amp.	56 turns	2¼" giant form
75 amp.	47 turns	1½" regular form

The somewhat odd bypassing arrangement seen in the wiring diagram allows the variable condensers to be mounted right on the metal panel without insulation and without resorting to shunt plate feed.

When the 802 is loaded to pull 55 or 60 plate ma., the load impedance is a little less than 10,000 ohms (due also to screen current), but it is close enough that the 10,000 ohm tap on the output transformer may be used without worrying about mismatch. The load impedance of class B 46's is not critical to within about 30% anyhow, and the discrepancy here is within that tolerance, besides being in the preferable direction.

It should be noted that in spite of the small size of the transmitter, all transformers and other audio components are standard size, no "transceiver" transformers being used. If weight is of prime importance, smaller audio transformers could be used to advantage, though there will be a reduction in fidelity, especially noticeable if a good microphone is used. With a single-button microphone there will not be as much difference, though it still will be noticeable.

Because none is used in this transmitter, amateurs should not take for granted that it is

perfectly o.k. to dispense with the buffer stage in any type of phone transmitter. Ordinarily, bad frequency modulation will result, and a crystal oscillator has not sufficient output to drive a plate-modulated class C triode anyhow, unless the input is very low. With the light loading permissible in this transmitter and "backing off" of the crystal oscillator tuning, no frequency modulation is noticeable even to a most critical listener.

◆

Key Clicks and Thumps

By JAYENAY

C.w. communication involves changing the carrier from full on to full off in order to define the dots and dashes of the code characters. When the change from "Mark" to "Space" is made too rapidly a bad click is produced which

Figure 1

can cause interference over a wide range of frequencies on each side of the carrier frequency. This click is caused by the fact that practically all keyed circuits contain some inductance and capacity which generate transients when the current in the circuit changes rapidly.

The amplitude of these transients can be ten to one hundred times the amplitude of the signal, although they usually last for a very short time, a hundredth of a second or less. In

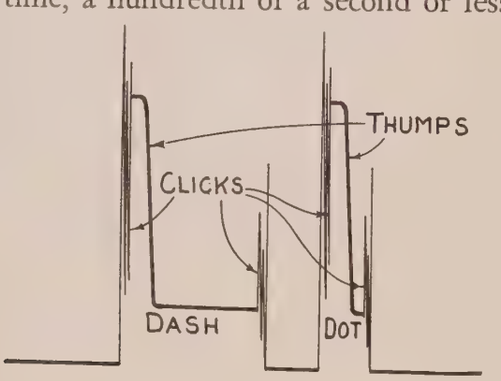


Figure 2

figure 1 is shown an ideal waveform of radio frequency output from a c.w. transmitter when the letter N is being transmitted. This waveform is never realized in practice. Figure 2 shows the same characters with the presence of bad clicks and thumps. The clicks and thumps are not exaggerated; in fact the clicks are shown relatively smaller than they often actually are, for convenience. In figure 3 is shown the shape of the keyed wave after proper click filtering has been installed. The absence of thumps also shows that the voltage regulation of the power

Figure 3

supplies has been improved.

Thumps are usually due to the fact that when the key is up the plate voltage on the final amplifier builds up to a very high value. This often occurs when a condenser input filter is used with center tap keying and no bleeder. The remedy is either to use choke input and a heavy bleeder, or else go to primary keying.

Clicks can only be eliminated by placing a low pass filter somewhere in the keyed circuit to slow down the build-up and decay of the plate voltage applied to the final amplifier.

The main problem in a key click filter is to make a filter that will eliminate the click at the "make" without increasing the click at the "break" of each dash. The usual form of click

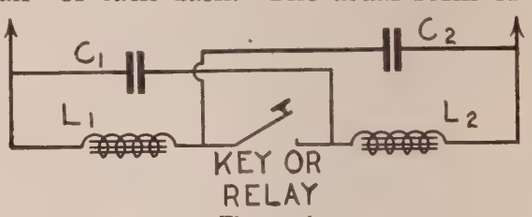


Figure 4

filter, which consists of a series inductance in series with the key or relay, kills the click at the start of each keying impulse but almost always causes a bad increase in the click at the break of each character. This click at the end, or break, of each character can be cut down by the use of a condenser across the key, but if this condenser is big enough to kill the click at the end of the character it is usually found that the lag in the circuit prevents it from following a bug satisfactorily.

The best answer seen yet is the circuit shown in figure 4, which uses two small chokes and two condensers. The chokes are about 4 henries each and the condensers 1 μfd. each for use in the average transmitter. However, as transmitters vary so widely it is impossible to lay down exact values that will suit every case; therefore some experimenting may be necessary.

◆

One nice thing about the new metal tubes (for the service man) is the fact that the poor b.c.l. cannot even tell if a tube is lit or not. Of course feeling of the envelope to see if it is warm is one way to tell if the tube is lit, but a few danger signs, warning against dire results should one dare put his hand on one of the tubes with the set on, placed in conspicuous places by the manufacturer should take care of that just dandy.

The Story of Cathode Biasing

By Boyd Phelphs, W9BP*

It is very common in modern receivers to obtain the grid bias by inserting a resistance in series with the cathode and chassis ground, making the plate current flow through this resistance, and utilizing the IR drop developed thereby for the desired control grid bias voltage as illustrated in figure 1. The plate current flows

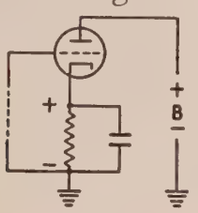


Figure 1

from cathode down through the resistor to ground, which is the most negative part of the series plate circuit. Therefore the cathode is positive with respect to ground and the average grid voltage is negative with respect to cathode.

If a "C" battery is used instead, an increase in plate voltage would cause a very considerable increase in plate current that might shorten the life of the tube, but with the cathode resistor system this is more or less automatically taken care of because the increased plate current causes a greater IR drop, which is a proportionately greater bias tending to bring the plate current back to normal for the increased plate voltage. Conversely, decreased plate voltage or current will not cause "cut-off" bias but only reduced bias in proportion. Thus far we have a review of a clever idea disclosed in patent number 1,403,932 to R. H. Wilson.

At about this time and the early days of Prof. Hazeltine's Neutrodyne, the writer experimented with circuits similar to figure 1 for neutralizing purposes, but of course without the bypass condenser across the resistance.

A simple mathematical analysis of figure 1 may be interesting. Let

E_g be a small a.c. voltage impressed on the grid circuit.

μ be the voltage amplification factor.

R be the resistance shown (figure 1) in the common grid and plate return to the cathode.

R_p be the internal plate impedance of the tube.

When the a.c. voltage E_g is applied to the grid it causes an a.c. voltage of $\mu(E_g)$ to appear in the plate circuit. The a.c. plate current equals:

$$\frac{\mu(E_g)}{R_p + R}$$

and as a result of this current there is a voltage-drop across the resistance R, equal to:

$$\frac{\mu(E_g)\ (R)}{R_p + R}$$

This a.c. voltage drop is 180 degrees out of phase with E_g and for complete neutralization we will therefore set them equal to each other as follows:

$$E_g = \frac{\mu(E_g)\ (R)}{R_p + R}$$

Solving for R and simplifying, we find that under these conditions it is necessary that,

$$R = \frac{R_p}{\mu - 1}$$

Therefore it would appear that the resistance required to cause a balance would be equal to the plate impedance divided by one less than the amplification factor. With screen-grid tubes, or other high μ tubes the "one less" is negligible. For almost all tubes the value of R comes out around 1000 ohms. Thus a 2000 ohm cathode resistor by-passed by a 0.1 microfarad

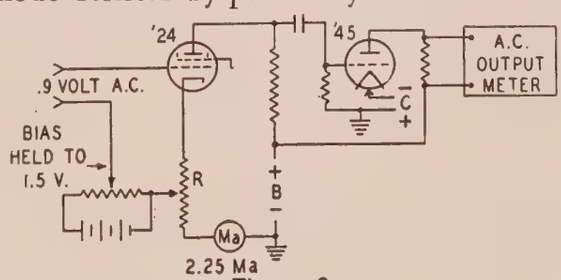


Figure 2
The Test Circuit

condenser (which at 800 cycles has a capacity reactance of 2000 ohms) would make a parallel combination having an 800 cycle impedance of about 1000 ohms, which would seem to cause neutralization of incoming signals impressed on the grid.

Actually, figure 1 is not quite so simple and was found not to be a good circuit for complete neutralization as a reduction of a.c. plate current caused a reduction of a.c. grid voltage and this reacted on the plate current again so other circuits, shown in patent number 1,829,013 granted to the writer, were found better suited.

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Returning to the cathode bias resistor, as it is increased from zero there is a very rapid reduction of over-all amplification of the stage due to this neutralization effect. The circuit of figure 2 was found convenient in a receiver chassis at hand by simply bringing out grid and cathode leads. As the grid return tap was varied on R, the bias voltage obtained therefrom varied so the potentiometer and battery were necessary as shown to bring the grid back to

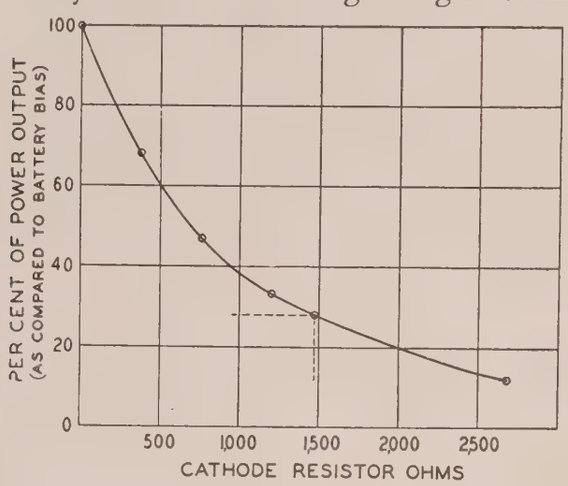


Figure 3

the same operating point on the tube's characteristic E_g I_p curve. This was most easily done by adjusting the bias to bring the plate current back to the normal value of 2.25 milliamperes, which was the current with a bias of 1.5 volts on the '24, and therefore the average bias was maintained at 1.5 volts by this procedure.

Check measurements were made at various frequencies but the wave form, it was feared, had considerably more harmonic content than the lighting circuit; so 60 cycles was introduced into the grid circuit at 0.9 volts r.m.s. This input was maintained as it gave a deflection of exactly 100 on the rectifier type output meter and did not seem to overload anything seriously or change the average plate current as read on the plate milliammeter. This full scale reading of 100 was obtained under the conditions of none of R being included in the grid circuit and the total bias of 1.5 volts being obtained from the battery. All other combinations gave output readings equal to or less than this. The output meter readings were proportional to the square of the voltage, so represented proportionate power level changes or percentages of maximum output of 100.

Fig. 3 shows how the readings on the output meter fell off as various amounts of R were included in the grid circuit. For example, the particular chassis used formerly had a 1470 ohm resistor in series with the cathode and the output (without by-pass condenser) fell to 28% of the power output obtained when the same bias was obtained from a battery, or *a loss of 72% on all frequencies.*

Reducing the size of the by-pass condenser results in the loss of low frequencies, but the above indicates that with no condenser at all this does not result in distortion but rather a sort of neutralization of all audio frequencies, resulting in uniform low signal output on all frequencies. Therefore, adding condensers across the cathode bias resistor must bring up the level of the high frequencies first, which is not contradictory but merely another way of saying the same thing, and a better basis for what is to follow.

All condensers have a certain capacity reactance which is equal to:

$$\frac{1}{2\,f\,C}$$

and for a certain frequency can be expressed as equivalent to a resistance of a definite number of ohms by this formula. A few of these are given in the table on page 23 as examples.

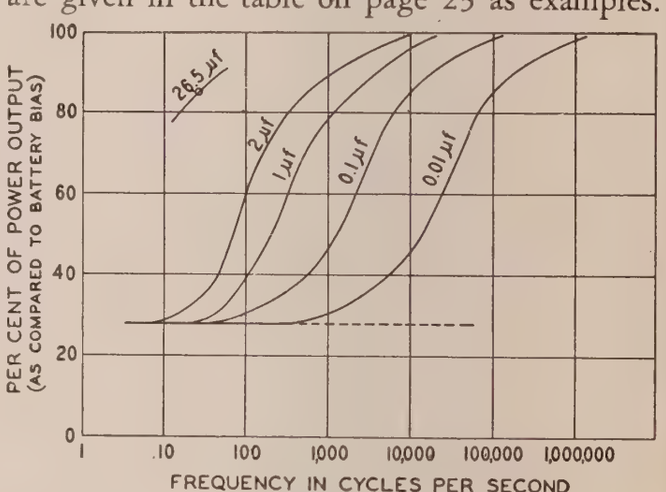


Figure 4

Unless one uses push-pull, or a circuit like figure 5, it is necessary to use high-capacity bypasses on audio cathode resistors. The common ½ to 1 mike is absurd—unless one has a poor filter and must get rid of hum and bass altogether!

Recalling the "reciprocal of the sum of the reciprocals" formula for resistances in parallel, one will see by inspection that unless the resistor by-pass condenser is quite large, its effect in reducing the effective resistance of R will not amount to much, especially on low frequencies. Take, for example, the 0.1 microfarad condenser that was found across the 1470 ohm resistor in the chassis used for these tests. It has a reactance of 159 ohms at 10,000 cycles, according to the table above, which across 1470 ohms gives a resultant of 143.2 ohms. Now

Table of Condenser Reactances

Frequency	*2 μfds.*	*1 μfd.*	*0.25 μfd.*	*0.1 μfd.*	*0.01 μfd.*
50 cycles	1,592	3,184	12,700	31,840	318,400
60 cycles	1,325	2,650	10,600	26,500	216,500
1,000 cycles	80	159	635	1,592	15,920
10,000 cycles	8	16	64	159	1,592

looking at the curve in figure 3, we find this would result in a drop of output from 100 to 85—about all we should tolerate. At 1000 cycles the reactance is 1,592 ohms, which about cuts the effective value R in half, or 763 ohms, and from the curve this would give only 46% of full output. Similarly at 100 cycles the output is only 30% while with no condenser at all 28% would be the lowest it could fall with a cathode resistor of 1470 ohms. This chassis in question would be quite terrible for audio quality but it had been designed for television and seemed to give fine image detail tolerably well in that field.

A number of measurements and calculations were made with various shunt capacities at various input frequencies and illustrated in figure 4. It may be rather surprising to some folks to learn that the common one and two-microfarad condensers should show up so poorly but it is so. To have the output drop to not less than 85% of normal at 50 cycles due to the effects discussed would require about 26½ microfarads.

All the above values are readings taken or calculated on one particular screen grid tube and do not exactly apply for other tubes and receivers but as the theoretical balance point figures around 1000 ohms for all tubes by the formula developed above, and the cathode bias resistor figures around 2000 ohms for most all tubes, it is felt that the principle, and quite closely the figures, will apply.

The circuit shown in figure 5 represents an interesting and cheap dodge to avoid the very large capacities that would otherwise be required to give fidelity on low tones. R_1 is the same 1470 ohms as before, R_2 is made high to force the "lows" through C_2 rather than be allowed to pass through R_1 and C_1, which contain only partially-cured low frequency fluctuations. The output circuit is not shown but is a duplicate of figure 2. The input was kept constant at 0.9 volts, 60 cycles and the following readings noted:

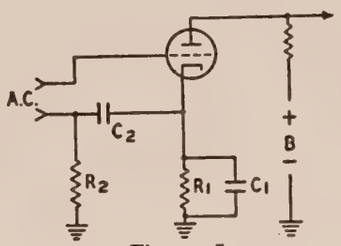


Figure 5
Test circuit with which the following values were obtained

C1	C2	R2	Output Percentage
		(battery bias)	100
1 μfd.	1 μfd.	100,000	100
0.1	1.0	100,000	97
0.1	0.1	100,000	68
1.0	1.0	50,000	97
1.0	1.0	33,333	74
0.0	0.1	100,000	67
0.0	0.0	100,000	28
0.1	0.0	100,000	30
1.0	0.0	100,000	35

A considerable mess of curves could be made up to show the effect of varying the above three factors in figure 5, but a study of the data in the above table should suffice. In short, C_1 is relatively unimportant, because dropping it from 1 to 0.1 microfarads dropped the power output from 100 to 97, and in another case where the output was 68 with the condenser at 0.1 it only dropped to 67 when it was removed.

C_2 seems to complain if it is dropped much below 1 μfd. but at that value is about equal in effectiveness to 30 μfds. in figure 1 type circuits, or practically the same as battery bias

Variation R_2 gives outputs of 100, 97 and 74 for resistance values of 100,000, 50,000 and 33,333 ohms respectively, which tells its own story.

◆

"Trigger" battery is an old term used to denote the C-bias battery. *Red magnetism* was used to mean the flux from a north magnetic pole, and the symbol, *CC* for direct current (continuous current). Doctors call alternating current *faradic* current.

◆

2A3 is a Massachusetts highway.

The New Tubes on Parade

The ratings on the 50T triode have been revised slightly upward after more than a year's experience with this type. The normal maximum plate loss is now rated at 75 watts instead of the original rating of 50 watts. The normal maximum average d.c. plate current rating has been raised from 100 ma. to 125 ma. The filament remains the same, being 5.0 to 5.25 volts at 6 amperes. The maker also announces that recent class B research on the 50T allows higher rated class B audio outputs to be obtained from two of these tubes.

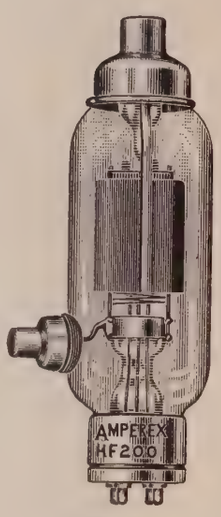
Class B audio (two tubes)

Plate Voltage	*Power Output*
1000 Volts	106 Watts
1250	150
1500	200
2000	260
2500	320
3000	350

The 300T triode is a new high frequency model and uses a 7½ volt, 11 ampere filament. The maximum diameter is 5 inches and the overall height is approximately 12 inches. The tube uses the standard 50 watt base and is similar in construction to the 150T and 500T. The normal maximum plate voltage is 3500 volts and the normal maximum modulated class C d.c. plate current is 300 ma. The μ is approximately 16. The rated maximum plate loss is 300 watts. Class C outputs of 750 watts can be expected from one tube.

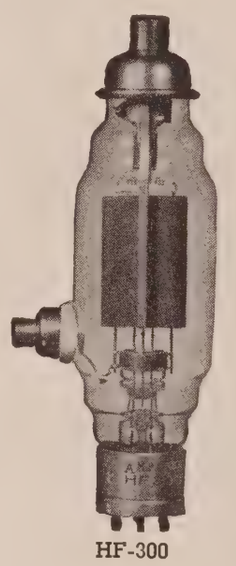
The 500T triode looks pretty large for amateur use, having a nominal class C rated output of 1350 watts, but nevertheless a number of amateurs have already put this tube on the air. One well known W6 uses a pair of 500T's in the final. The 500T has a 7½ volt 20 amp. filament and an amplification factor of 13. The normal maximum plate voltage is 4000 volts and the normal maximum modulated class C d.c. plate current is 450 ma. The very low interelectrode capacities allow high output to be obtained up to 75 megacycles. The maximum class B audio output of two 500T's is 2000 watts of sine wave audio. The maximum rated plate loss is 500 watts and the tube uses a special four pin base. The manufacturer uses tantalum as anode and grid material and the plate lead comes out the top and the grid lead out the side in all models.

The HF200 triode uses a 10.5 to 11.0 volt filament at 3.4 amperes. The amplification factor is 18 and the rated maximum plate loss is 150 watts. The maximum allowable plate current is 200 ma. and the nominal rated class C power output is 250 to 350 watts. The anode material is carbon and the rated maximum plate voltage is 2500 volts. The inter-electrode capacities are quite low and the plate voltage does not appear across the one internal insulator.

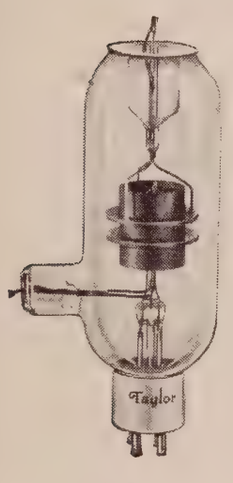


HF-200

The HF300 triode is quite similar to the HF200 except for its size. It has a 11 to 12 volt filament which draws 4 amperes. The amplification factor is 23 and the maximum rated plate current is 275 ma. The maximum rated plate voltage is 3000 volts and the nominal rated power output is 400 to 600 watts. Both the HF200 and the HF300 use the standard 50 watt base. The HF200 is similar to a high voltage 211 with most of the 211 disadvantages eliminated, while the HF300 seems related to the 204A with many of the 204A disadvantages eliminated. Both these tubes attain high transconductance by using a flat grid and plate structure, like the 211 and 04A, yet the inter-electrode capacities are kept low by using large element spacing and by bringing the grid and plate leads out from the side and top respectively.


HF-300

The F52 triode is the newest addition to the low C tube family. The general design is first cousin to an 852 and it uses a four pin base. The filament uses 10 volts at 3.85 amps. The amplification factor is 12 and the tube differs from an 852 in that the grid lead comes out the side and the plate lead comes out of the top of the envelope. The maximum unmodulated plate voltage is 3000 volts and the maximum d.c. plate current is rated at 100 ma. The anode material is carbon and the rated maximum

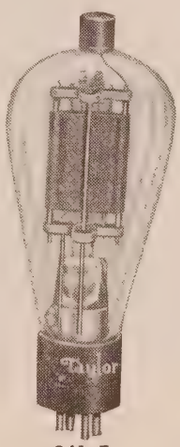


F-52

plate loss is 150 watts. The nominal class C power output is from 175 to 250 watts and the inter-electrode capacities are only slightly higher than an 852.

The HD203A triode is an overgrown 203A. It uses a 10 volt 4 amp. filament and the plate lead is brought out of the top of the envelope. The maximum rated plate voltage is 1750 volts and the normal maximum d.c. plate current is rated at 250 ma. A pair of these tubes used as class B modulators are rated at 500 watts of audio power output. The maximum rated plate loss is 150 watts and the amplification factor is 25. The nominal rated class C power output is from 225 to 300 watts.

The 841A triode is quite similar in many respects to the type 30B tubes (830B and 930B). The filament requires 10 volts at 2 amps., and the amplification factor is 28. The maximum rated plate voltage is 1000 volts and the maximum rated d.c. plate current is 150 ma. The rated maximum plate loss is 50 watts and the tube uses a four pin UX base. The plate lead is brought out of the top of the envelope and the anode material is carbon. Note that this tube is considerably larger than the standard 841 and is not interchangeable with it. The rated class B audio output of two tubes is 200 watts at 1200 volts. The nominal class C rated power output is 75 watts.



841-A

The 825 triode should not be confused with the old Sylvania 825. Though it is somewhat similar it much more closely resembles the Sylvania 830 (*not* the 830B). The filament requires 7½ volts at 2 amperes and the rated maximum plate loss is 40 watts. The amplification factor is 9 and the maximum allowable plate voltage is 850 volts. The grid, plate, and filament leads are brought out to a UX 4 pin base. The anode material is carbon. The maximum d.c. plate current is 110 ma. and the nominal class C power output is 35 to 50 watts. Two of these 825's in class B audio will give an output of 85 watts into an 8000 ohm load, at 850 plate volts.

The 866B rectifier is about half way between the 866 and the 872. It is a half wave mercury-vapor hot cathode rectifier. It uses a 5 volt 5 ampere filament and the maximum peak space current is 1 ampere. The maximum inverse peak voltage is 8500 volts, which means that a pair of these tubes may be used to give about 2750 volts of d.c. voltage into the filter. The bulb is the UX250 type and it uses a four pin base with the plate lead out of the top of the tube.

The RK28 150 watt power pentode is now reported to have a 10 volt 5 ampere filament. The newest ratings are reported to be 100 watts maximum plate dissipation and 35 watts screen dissipation. The RK30 is somewhat similar to the type 800. It uses a 7½ volt, 3.25 amp. filament, and the grid and plate leads are brought out of the top of the envelope. It is suitable for ultra high frequency use. The maximum plate voltage is 1250 volts, the maximum rated plate current is 100 ma., and the nominal class C output is 65 watts.

The RK32 is another somewhat similar high frequency triode with only the plate connection out of the top of the envelope. The filament requires 7½ volts at 3.25 amps. and the maximum rated plate current is 100 ma. The maximum plate voltage is 1250 volts and the maximum rated plate loss is 50 watts.

The RK31 is a zero bias high μ triode designed primarily for class B audio use. It uses a 7½ volt, 3.00 amp. filament and the maximum rated d.c. plate current is 100 ma. The plate lead is brought out of the top of the envelope and it uses a 4 pin base. The nominal class B rated output (two tubes) at the maximum plate voltage of 1250 volts is 140 watts. The maximum rated plate loss is 50 watts.

◆

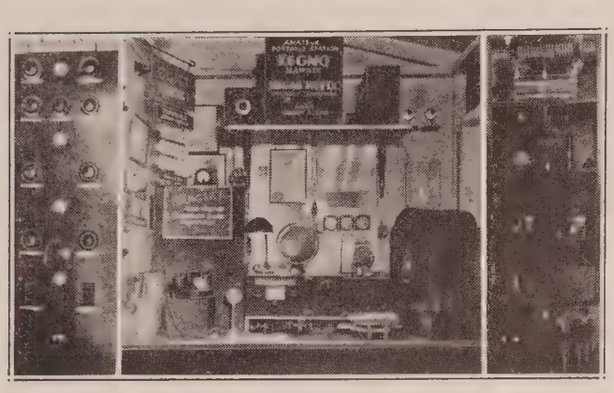
W. S. Van Dyke, movie director, was kept in touch with his Hollywood studio by W6BZM while the former worked on a picture in the Marquesas Isles, 5,000 miles away.

◆

Short wave communication has figured in the filming of several motion pictures. In one, the frigate *Old Ironsides* was equipped with a set which picked up the signal to drop certain spars and masts at the proper moment to give the effect of their being shot away.

◆

Ever so often we hear of Nikola Tesla. Tesla Nicola, however, is a medic in Ethiopia.



K6GAS

One of the most consistent signals heard from Hawaii gets its start at K6GAS, operated by Henry Lau. Henry first came on the air under the call of W6FUC in Los Angeles in 1932. The two 210's in t.g.t.p. "just growed" until the present transmitter evolved, consisting of a pair of 50-T's in the final amplifier. Normal input on c.w. is 600 watts and on phone about 400 watts.

The majority of operation consists of brass pounding on 40 meters, but Henry takes an occasional fling at 20 meter phone. A pair of carbon plate 203A's in class B enable Henry's voice to agitate the two 50-T's, and he puts quite a dent in the 20 meter phone band when he is on.

Henry likes dx, and also likes to handle traffic of genuine importance, but his chief interest lies in "chewing the fat" with fellow amateurs, whether they be across town or across the pond.

For most c.w. reception a National FB7A with preselector is used. On phone, an R.C.A.-128 does its stuff.

Four different directional antennas are used. One is a 40 meter full-wave "V" aimed at the U.S.A., each wire being 136 feet long. Another is a half wave zepp. oriented for maximum signal to the Far East. The third and fourth are variable-beam 5-meter antennas.

A completely d.c. operated stand-by transmitter and receiver are kept in working condition at all times. Henry also uses this transmitter to talk home when spending a weekend in the country.

K6GAS is better known to some as ex-AC8GAS, the call he uses when in the Orient. Henry makes a business of QSL'ing 100% except, of course, when the QTH is not known.

BEST TIMES FOR 20 METER RECEPTION

Antigua	0100-0300
Argentine	2300-0600
Australia	1300-1600
Bermuda	0100-0300
Brazil	1900-0300
Canal Zone	1200-0600
Chile	0100-0600
Cuba	1400-0300
Costa Rica	1430-1800
Dominican Republic	1900-0400
England	1400-2100
Germany	1500-0800
Jamaica	1330-1730
Mexico	1200-0600
New Zealand	0430-1500
Nicaragua	2200-0100
Peru	2130-0130
Porto Rico	2200-0100
Sweden	1900-2100
Uruguay	2300-0100

*These are the exact times in G.m.t. that the above countries are being heard in the central United States on 14 mc.

◆

VR4BA, who has been heard consistently on 14 mc. recently, is exVK2BA, B. A. Chapman. His present QRA is Makambo, British Solomon Islands.

◆

ZS2A of Uitenhage, South Africa, will be back on the air by the time this appears in print. He will operate an entirely new station and do considerable work on 28 mc. He will keep regular schedules in the hope of establishing reliable QSO's on that band. The exact time of the transmissions has not been determined, but will depend upon the activity in the band.

The transmitter at ZS2A will consist of a 50T in the final, with an 802 buffer, and two 53's as doublers.

ZS2A is anxious to establish QSO's with "W" stations on 28 mc. He has a "super" in operation for reception.

◆

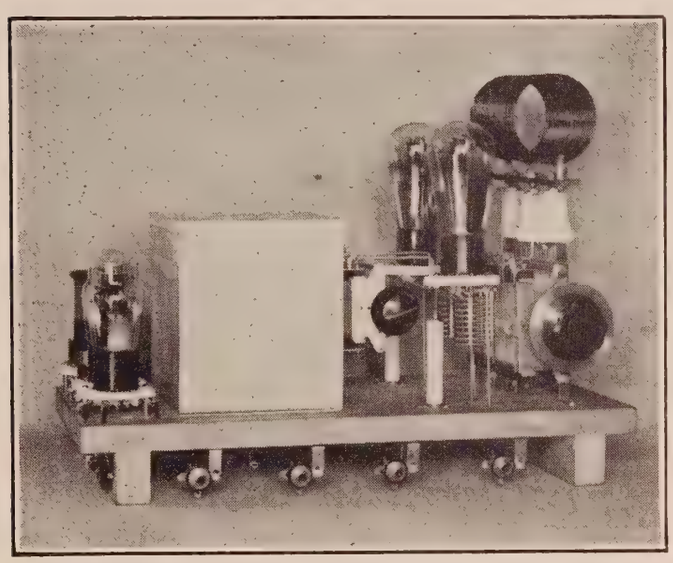
John Ramcke, DE2491J, Hamburg, Germany, is listening regularly on 28 mc. and will be glad to listen for any station and report reception. He can be reached by addressing a card to Deutsche Kurzwellen-Station, Hamburg.

An Inexpensive 210 Transmitter

By Martin A. Brown, W6ABF

The type 10 triode has earned the title of "old faithful" by virtue of its long-standing record as a star-performer. In proportion to its size and filament power, it will stand more abuse than any tube generally available for transmitting work, excluding, of course, the deluxe edition of the same type (801). Here is a c.w. rig using three type 10's. No fancy innovations, just a good transmitter that really works.

Probably the most popular tube for amateur transmitter use is the 210 type. This tube has been the leader for the last 10 years and will probably continue to be for the next ten years, particularly now that its cost has come down to its present low level. In view of this fact the technical department of Radio will present every



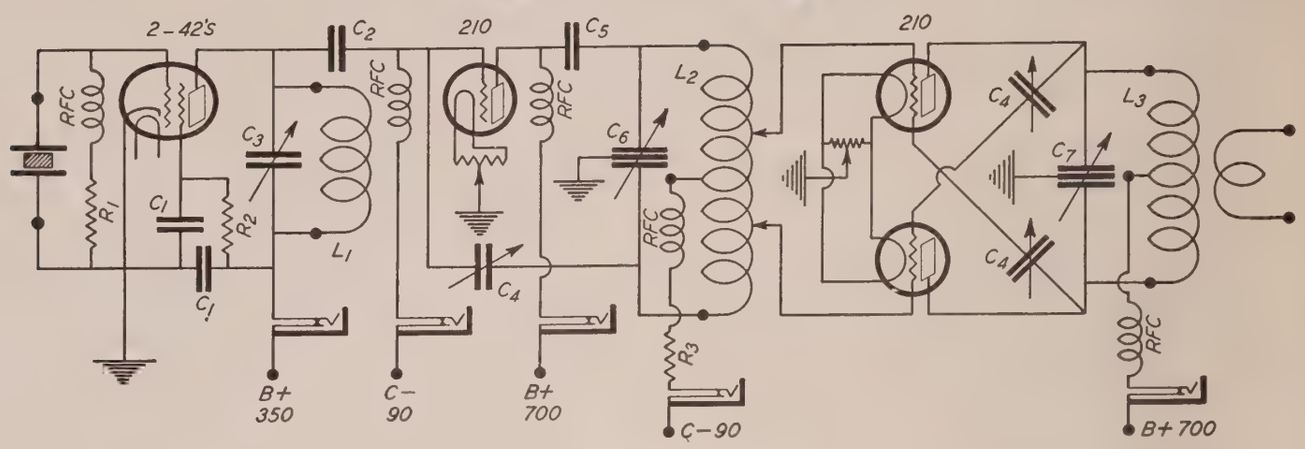
month or so, a transmitter using this well and favorably known tube.

The first such transmitter is a 75 to 100 watt c.w. transmitter using parallel 42's in the crystal oscillator, a single 210 as buffer-doubler, and push-pull 210's in the final amplifier. It was decided to avoid the more complex exciter units in this first transmitter in order to avoid as many bugs as possible. Therefore a standard crystal oscillator circuit is used. The use of two 42's in parallel adds no complication and less than a dollar of cost, while it practically doubles the power output of the crystal stage. The use of the two 42's also has the advantage that the grid of the 210 buffer stage, which is capacitatively coupled to the oscillator, can be tapped directly on the plate end of the oscillator tank coil instead of being tapped down on the coil, which would be necessary when using only one pentode as oscillator. This simplifies the circuit and also minimizes the possibility of parasitic oscillations in the 210 stage. However, it might be noted that 210's are much less subject to parasitic oscillations than the 46 type of tube, so that this precaution is not absolutely necessary.

The circuit diagram is shown in figure 2 and it will be seen to be very conventional in practically every respect. Series feed is used in the oscillator and final amplifier, while both the grid bias and the plate voltage to the 210 buffer-doubler stage are shunt fed through r.f. chokes.

Capacitative vs. Link Coupling

Generally speaking, link coupling between stages is more desirable than capacity coupling. However, the use of capacity coupling in this particular transmitter was considered desirable for various reasons. In the first place, contrary to popular opinion, capacitative coupling introduces no more *losses* than other methods of coupling. The introduction of a loss necessitates the dissipation of power in some form, usually heat. It is well known that the coupling condenser or the r.f. choke (assuming a good one) do not materially heat, so that no energy is actually lost. What usually happens to make the use of the capacity coupling undesirable is that the one-to-one ratio of impedance transformation usually present where the grid of the driven tube is capacity coupled to the plate of the driver tube causes the resistance of the grid of the driven tube to reflect back something other than the optimum load for the plate circuit of the driver tube. Thus what happens is that either the driver tube is not allowed to generate its quota of output or else it is forced to generate that output power inefficiently. If care is taken, by means of properly located excitation taps on the tank circuit between two capacitatively coupled stages, or by choosing proper tube combinations, it is possible to get just as much driver output and grid drive to the driven stage with capacity coupling as with any other type of coupling. It just happens that link coupling is somewhat easier to adjust for



The Wiring Diagram

R_1—10,000 ohms, 2 watt carbon.
R_2—15,000 ohms, 10 watts.
R_3—2500 ohms, 10 watts.
C_1—.01 µfd. mica.
C_2—250 µµfd. mica.
C_3—70 µµfd.
C_4—15 µµfd. double spaced midgets.
C_5—.002 µµfd. 1000 volt mica.
C_6—70 µµfd. per section, each 2000 volt spacing or greater.
C_7—200 µµfd. per section, 3000 volt spacing.

optimum coupling, or what might better be termed proper impedance transformation between the load and the power source. In this transmitter, the tubes and plate voltages were chosen so that the coupling problem is simplified. The test of any coupling method is to see that the driver stage draws proper plate current without excessive plate loss. If that requirement is satisfied, we will have all the grid current on the driven stage that we have a right to expect. Thus the use of paralleled 42's as crystal oscillator allows the grid of the 210 buffer stage to reflect back just the right load impedance for the 42's. The use of 90 volts of bias on the 210 buffer allows it to operate approximately class B, which is the condition for maximum power gain, yet still allows a plate efficiency of better than 60%. The proper adjustment of the neutralizing condenser C_4 when doubling in the 210 stage allows high doubler output to be obtained without the necessity for high doubler bias and grid excitation.

Design and Construction

Note that there are only three tank coils in the transmitter. The tuning condenser for the crystal oscillator seems to be missing from the photos of the transmitter. However, this is due to the fact that the oscillator tuning condenser is mounted inside of the plate coil for the oscillator, and, once set, the tuning is fixed. Thus when changing bands it is not necessary to retune the oscillator. The oscillator plate-tuning condenser is of the mica trimmer type mounted inside of the coil form. An air tuned condenser could have been used but the mica compression type has held up well and is somewhat cheaper. There is nothing tricky about the transmitter. Due to the fact that a slight excess of output from the buffer-doubler is available on all bands, a slight mismatch at that point is not bothersome, and the grid taps may be clipped right on the ends of the buffer coil.

The breadboard used is interesting in that it is the first showing of the new RADIO standard breadboard for use in all development work. It is 17 inches wide, overall, and thus fits between the supports of a standard relay rack. A panel can easily be mounted in front of the breadboard and the whole thing mounted in any standard rack. A standard wooden supporting rack for those who do not wish to use metal relay rack construction will be shown in an early issue. The breadboard is 8½ inches deep; thus the breadboard is twice as wide as it is deep. The material is slightly less than one inch thick, and the supports are slightly over one inch high. The supports are accurately located so that their outside width under the breadboard is exactly 15 inches. This width is important as it allows the board to be firmly supported by the wooden rack mentioned above. It might be mentioned that the other size of RADIO standard breadboard is 8½ by 8½ inches, which is a handy size for individual stages of a transmitter. If these sizes are standardized it will help in exchanging equipment among ham stations, and will also enable manufacturers to offer cheap quantity-production rack-and-panel and breadboard equipment for sale, which will benefit everyone.

The buffer stage is mounted inside of a simple shield box which is available commercially in three parts (bottom, sides, and a top). This shield box materially improves the isolation between stages, as it shields all three stages from each other.

The mechanical layout of the final amplifier is rather unusual in that the tubes are mounted well up in the air. This allows exceptionally short r.f. leads throughout the final amplifier, which is highly desirable for high frequency use. It also pays to keep the wooden breadboard away from r.f. fields, as wood is generally a rather poor dielectric and causes losses when too close to tank coils and r.f. leads. The neutralizing condensers are all mounted vertically and have their shafts slotted so that they can be adjusted from above with a screwdriver. Due to the symmetry of the circuit, the neutralizing condensers will seldom have to be readjusted when changing bands.

The method of coupling the final amplifier to the antenna is by means of link coupling to a separate antenna tank, which is cheap, simple, and very effective. This same unit will be shown later driving a pair of 150T's to a kilowatt input in a phone transmitter now under development. As a matter of fact, this exciter has nearly twice as much output as required by the 150T's but in order to make sure that enough will aways be available, this excess was provided.

The transmitter is keyed in the primary of the high-voltage supply, which removes plate voltage from both the buffer and the final amplifier when the key is up. Thus pure grid leak bias could be used on both 210 stages, but external bias is shown to allow center tap keying of the final amplifier should one wish to use it.

Some typical operating conditions follow: Oscillator plate current, 65 ma.; buffer grid current, 20 ma.; buffer plate current when amplifying, 55 to 65 ma.; buffer plate current when doubling, 80 ma.; final amplifier grid current, 33 ma.; final amplifier plate current, 160 ma.; r.f. power output, 85 watts (accurate to 10%).

Of course these output figures can easily be exceeded, but they are typical of average conditions.

◆

Some of the boys at R.C.A.-Victor advise us that the 4%, or so, distortion of an 838 pair of class B audio tubes can be reduced to about 1% by using a fixed bias of about 15 volts. Of course that re-introduces the bias supply—but did you expect to get high fidelity for nothing? Not by a jugfull; it not only takes a bias but it takes first rate transformers with this or any other kind of tubes. 1% is really something.

A.R.R.L. Directors Elected

Because they had no competition in their divisions, the following candidates were declared elected by the A.R.R.L. Executive Committee:

DAKOTA DIVISION:
Carl Jabs, W9BVH, *Director*
Fred W. Young, W9MZN, *Alternate Director*

DELTA DIVISION:
Fremont F. Purdy, W4AFM, *Alternate Director*

PACIFIC DIVISION:
S. G. Culver, W6AN, *Director*
E. L. McCargar, W6EY, *Alternate Director*

SOUTHEASTERN DIVISION:
Bennett R. Adams, W4APU, *Director*
S. J. Bayne, W4AAQ, *Alternate Director*

A.R.R.L. Directorship Nominations

The following were duly nominated as candidates for the positions of Director and Alternate Director in the divisions indicated, and ballots are in the mails as this is written. The nomination of Mr. Gilbert L. Crossley for the directorship of the Atlantic Division was cancelled at his request, and is omitted from this list:

ATLANTIC DIVISION:
for Director:
Lawrence D. Geno, W8PE
Dr. Eugene Woodruff, W8CMP
for Alternate Director:
Ward J. Hinkle, W8FEU
W. Bradley Martin, W3QV
Roy C. Corderman, W3ZD

DELTA DIVISION:
for Director:
E. Ray Arledge, W5SI
E. H. Treadaway, W5DKR

MIDWEST DIVISION:
for Director:
H. W. Kerr, W9DZW
Floyd E. Norwine, Jr., W9EFC
Frank J. Sadilek, W9APM
for Alternate Director:
O. J. Spetter, W9FLG
Phil D. Boardman, W9LEZ

SOUTHWESTERN DIVISION:
for Director:
Charles E. Blalack, W6GG
Walter E. Matney, W6EQM
for Alternate Director:
William L. Seitz, W6HXU
Philip S. Snyder, W6UT

Balloting closes on December 20th at West Hartford. All licensed amateur members are urged to vote. Vote as you please, *but vote!*

◆

The plate current in a thyratron tube is several *amperes*.

A Wide Range, High Wattage Rheostat

By Robert S. Kruse

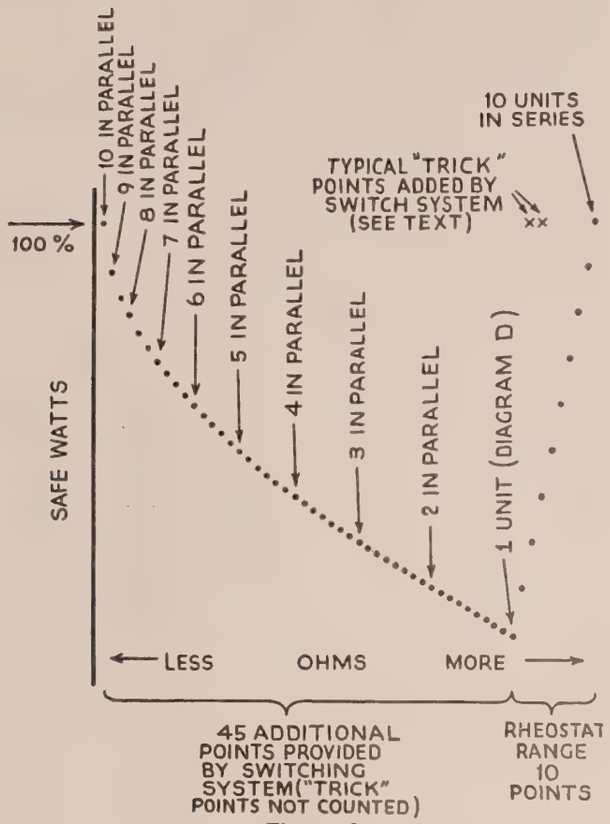


Figure 1
What can be done with 10 resistors in the circuit of figure 2.

How would you like to have the job of connecting 10 resistors, each of 100 ohms, in 55 different ways so as to give 55 resistances, ranging from 10 ohms to 1000 ohms by the even steps shown in figure 1?

Some job? No, it can be done in 2 minutes *without hurrying.* To do it one uses a simple arrangement which is familiar to most power-generating men, but not much seen in radio stations or laboratories, where it is none the less very useful.

The First Switching Scheme

The switching sounds complicated, but in 5 minutes you can learn to "run through" it as fast as claimed above.

The switching arrangement necessary to do the thing is shown in figure 2A, which shows all switches open; hence there is no circuit between the two busses, though one end of the resistor string is tied to the lower bus. For discussion each switch is given a number, which is the same as the number of the resistor to its left.

Now in diagram 2B we have closed number 10 switch "up", thus placing the 10 resistors in series across the busses, and giving a resistance of 10 × 100 = 1000 ohms.

Now we start to run through the ordinary "10 point rheostat" range by shortening the resistors one after the other. This is done by first closing no. 9 switch "up" as shown in diagram 2C, which gives 900 ohms, then closing no. 8 up (800 ohms) and so on until we arrive at the 10th step, shown in diagram 2D with only one resistor in circuit, therefore 100 ohms.

The Series-parallel Range

This is where the ordinary rheostat leaves off. We could of course tap the last resistor and get down further as to ohmage, but the increasing current would fry the life out of the

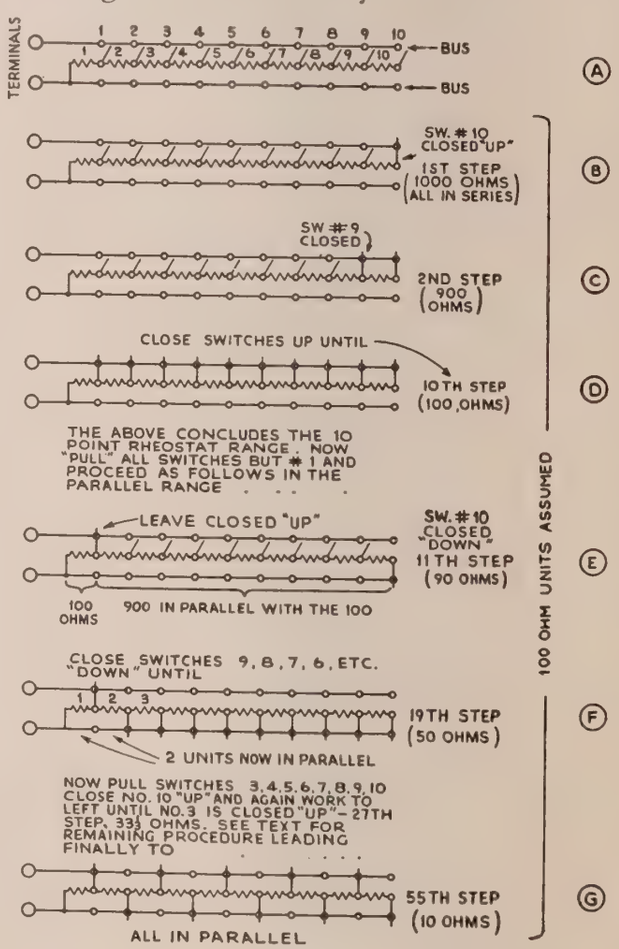

TERMINALS
1 2 3 4 5 6 7 8 9 10
BUS
BUS
A
SW. # 10 CLOSED "UP"
1ST STEP (1000 OHMS ALL IN SERIES)
B
SW. # 9 CLOSED
2ND STEP (900 OHMS)
C
CLOSE SWITCHES UP UNTIL
10TH STEP (100 OHMS)
D
THE ABOVE CONCLUDES THE 10 POINT RHEOSTAT RANGE. NOW "PULL" ALL SWITCHES BUT # 1 AND PROCEED AS FOLLOWS IN THE PARALLEL RANGE . . . .
LEAVE CLOSED "UP"
SW. # 10 CLOSED "DOWN"
11TH STEP (90 OHMS)
E
100 OHMS
900 IN PARALLEL WITH THE 100
CLOSE SWITCHES 9, 8, 7, 6, ETC. "DOWN" UNTIL
1 2 3
19TH STEP (50 OHMS)
F
2 UNITS NOW IN PARALLEL
NOW PULL SWITCHES 3, 4, 5, 6, 7, 8, 9, 10 CLOSE NO. 10 "UP" AND AGAIN WORK TO LEFT UNTIL NO. 3 IS CLOSED "UP" — 27TH STEP, 33⅓ OHMS. SEE TEXT FOR REMAINING PROCEDURE LEADING FINALLY TO . . . .
55TH STEP (10 OHMS)
G
ALL IN PARALLEL
100 OHM UNITS ASSUMED

Figure 2
The switching scheme which is called "number one" in this paper, and is shown in the photograph.

poor resistor, just as it commonly burns out the last few turns of the small wire-wound rheostats.

Since we are not using the other 9 resistors we accordingly start placing them in a series-

parallel arrangement. First we "pull" all switches *except no. 1,* which continues to keep the no. 1 resistor across the busses. Then we close the no. 10 switch *down* as shown in diagram 2E, which is seen to place 900 ohms in parallel with the 100 ohms, thus giving 90 ohms.

We again proceed to short-circuit one resistor after another except that this time we close the switches down instead of up—always taking our cue from the position of the no. 10 switch. In due course we arrive at diagram 2F, having made 19 steps; we now have two resistors in parallel, giving 50 ohms able to handle *twice the current* which the "D" position of our 10-point rheostat could stand.

Do You Want More?

Once more the switches are pulled except no. 1 *and* no. 2. No. 10 is once more closed "up" and we again start cutting off units by closing from right to left, again following the no. 10 switch's position and thus getting 3 resistors in parallel.

Eventually we arrive at diagram 2G with 10 ohms, all units in use and able to handle *10 times the current* of the 10-point rheostat.

Now let us stop to compare what has happened.

	10 point rheostat	*"Number one" system*
Greatest resistance	1000 ohms	1000 ohms
Steps from 1000 to 100 ohms	10	10
Steps below 100 ohms	none	45
Greatest safe current	X	10X
Lowest available resistance	100	10

Yes—it still *sounds* complicated, but we insist that you can learn to do it in 5 minutes. Surely you are as bright as a 7-year-old boy!

The Practical Effect

Sticking for the moment to our set of 10 resistors of 100 ohms each, let us assume that they can dissipate 160 watts apiece, which is to say they can stand a current of a little more than 1.25 amperes.

If we connect the things as a simple 10-point rheostat they cannot handle more than this 1.25 ampere, but with our "number one" circuit we can run on down to 10 ohms and handle 12.5 amperes without the resistor getting burned up about it. Thus our rheostat not only is good for small-current work at resistances up to 1000 ohms, but also it is good to put in the primary circuit of transformers.

Damage-proof

Nor is that all. We picked those 160 watt, 100 ohm units for a dark reason. Suppose you slap *one* of them across the 110 volt line by accident, such as having the thing in series with them get short-circuited. What happens? Why 1.1 ampere flows through—nothing happens except a little safe heat. If you put all

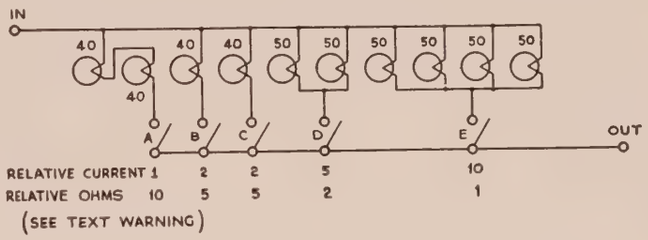


Figure 3
The more limited or "number two" switching scheme. This is shown in the second photograph.

10 of them in parallel as in our switch position no. 55, shown in diagram 2G, nothing happens again. We draw 11 amperes but it is divided among 10 resistors and they are calm.

There is no necessity for sticking to one particular size or ohmage in these units; we merely mentioned the 100 ohm, 160 watt resistors as being practically amateur-proof, and big enough to handle any decent amateur load. If you don't burn watts so freely, use smaller resistors of smaller ohmage. It is often convenient to be able to change ranges by changing resistors.

The 2d Switching Scheme

Another switching scheme, of lesser flexibility, is shown in figure 3. Made up with tungsten lamps of the wattages shown, and connected to a line of the proper voltage for those lamps, it would make a rough approximation to the "relative current" and "relative ohms" indicated. The roughness of the approximation is due to the fact that the two lamps in series are running cooler than the rest. If you can find a single 20 watt lamp instead, the thing will strike closer, but you now have three sorts of lamps, one of a size that isn't useful in the house. It is better to stand the off-color combination shown.

Lamp Limitations

In this *or any other* arrangement, lamps change resistance with voltage. Their main merit is that they are cheap and can be borrowed from the lighting fixtures, or bought at the Atlantic & Pacific store as well as the 5 and dime and corner drug store. On the ordinary lighting line we know the 50 watt lamp passes about ½ ampere if there is nothing in series with it—which there usually is. Thus for the lamp arrangement shown the actual current stated in amperes will be about 1/5 of the figure stated as "relative current".

The No. 2 Switching Scheme

This is a purely parallel switching scheme. It has 20 steps which are as follows:

Switches closed (Indicated by the letters)	*Relative current*
A	1
B	2
A,B	3
B,C	4
A,B,C	5
A,D	6
BD,	7
A,B,D	8
B,C,D	9
E	10
Now keep E closed and re-run the above to add another 10 by steps of 1. Final stage is:	
A,B,C,D,E	20

In making up a rheostat of this sort the "relative ohms" and "relative current" figures can be marked on the base if there is any intention to change the units at any time. If they are to be left unchanged (incredible in an amateur station) the ohms for each switch may be written down on the base.

A better rheostat of this sort would consist of the 60 watt units referred to before. 200 ohm ones would be required to replace the 50 watt lamps, and 250 ohm ones to replace the 40 watt lamps. The resulting rheostat goes from 500 ohms to 25 ohms in 20 steps. The maximum current which may be handled safely is about 4.5 amperes.

Thus our final comparison comes out so:

Comparison of 10-unit resistor systems, assuming 100 watt units of 100 ohms each, also some 125 ohm units in scheme no. 2.

	10 Point Rheostat	Switching Schemes	
		No. 1 (fig. 2)	*No. 2 (fig. 3)*
Number of points	10	55	20
Switches required	10 1-pole or 1 rotary with 10 points	10 1-pole double throw	5 1-pole
Largest safe current	1 ampere	10 amperes	8 amperes
Largest resistance	1000 ohms	1000 ohms	250 ohms
Smallest resistance	100 ohms	10 ohms	12.5 ohms

The whole thing can be complicated a great deal by adding more units, but the principal effect will be to make scheme no. 1 look better than ever. With 20 units it has—but it is midnight and we'll not go into that.

◆

The earth has a negative potential of 630 million volts.

Alfred H. Grebe

To be remembered with pride is for some. To be remembered with both pride and affection is reserved for a few. Of these few is Alfred H. Grebe.

His love for perfection, and his ability to create it, made for him a place in radio such that we find it hard to believe that he was but 40 years of age when his endeavors were ended.

The desire to go forward appeared early. A commercial operator at 15, a manufacturer before 20, Grebe soon became known for those superbly-made rotary spark gaps and shortwave regenerative receivers which were the showpieces of their time. The desire to know that everything was right presently caused the Grebe factory to become self-contained. The "Synchrophase" broadcast receivers grew from raw material to final product in the same building. These receivers were unique in their time and type for gain and for selectivity; Grebe had also known where to secure capable circuit engineers. Later there came 5-gang t.r.f. receivers of unprecedented performance. At other times tone control, high-fidelity audio, one-control tuning, and the straight-frequency-line condenser all appeared in the Grebe line as pioneer improvements. The flag stayed at the masthead when the "buyer's market" appeared. Grebe sets remained good, but they became fewer and finally were gone. Their memory did not go, nor that of the man who willed them into being.

Meantime broadcasting stations WAHG and WBOQ had been built, to be followed by the Atlantic Broadcasting Corporation and WABC, later key station of the Columbia Broadcasting System. They were excellent stations.

So far we have mentioned the things for which "Al" Grebe is remembered with pride by this industry. As to the affection—many of us used his equipment, and found it honest. Some of us knew him and will nod our heads in understanding when we recall that in the growth of the Grebe factory his own home was torn down to make room, but the linden tree was left standing. It had been planted by his father.

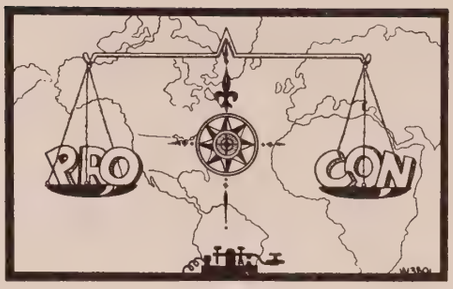
◆

Master Who Talks With the Winds was the name given Clyde de Vinna, W6OJ, by African natives who saw him operate a transmitter in the jungle.

◆

The British originated the R system for indicating audibility.

THE OPEN FORUM



Des Moines, Iowa.

Sirs:

I have just read of the death of Colonel Foster. To say that this is a blow would be putting it mildly. It is a loss—a distinct and irreparable loss. For if there is anything of value to youth in older people, it is the generosity of the older ones in giving to youth the lessons they have learned. This generosity the Colonel had in more abundance than any other man I have known.

He might much more conveniently have withdrawn to himself and his own affairs, than to have plunged into association with youth as he did. But he reveled in making his own experience of value to a younger generation. He "got a kick" out of it. He was no "oldster" in his ideas, and I know there are many, like myself, who are grateful to him for the "lifts" he gave in figuring out the world for what it is. Such men as he really contribute something to society.

I wish that he were still here but, now that he is gone, he will not be forgotten soon. Honesty, sincerity, patience, industry, the joy of living, the triumph of what is right—they all seemed a part of Colonel Foster. A host of his friends, fighting for these same things, often will think of him in their battles.

Many there are who knew him and, friend or enemy, none but would say, "This was a man." But of them all, I am sure the greater number would say, "This man was my friend!"

LOUIS R. HUBER, W9SU.

◆

Mayor's Office,
Moss Landing, Calif.

Sirs:

Remember when the "administrators" at Hartford were going to help the poor starving radio parts manufacturers get rich by popularizing private 5 meter intercommunication? Well, I guess that the hams made such a squawk that they got scared out. Anyhow, nothing seems to have ever come of it.

Where they made the big mistake was in picking on 5 meters instead of 35,000 meters. Nobody uses that part of the spectrum (at least I have been unable to hear anything there on a Federal long wave receiver) and it wouldn't bother the hams any because the harmonics would be pretty weak by the time they got down to the amateur bands.

Yep, if we want to keep our amateur bands intact, we had better start trying to sell the general public on the 35,000 meter band, because sooner or later everybody is going to want a hunk of the air for himself. Just imagine the general public trying to put a rig on that band! It sure would increase the sale of wire, and

help bring back prosperity to this nation if 25,000,000 35,000-meter antenas went up in 5 years.

Of course no code test would be required of the poor public. If they erected a half-wave 35,000 meter antenna it would prove that they had the radio art imbedded deeply in their hearts, and that they should be entitled to a share in the ether (or chloroform).

"THE MAYOR," W6DDS.

◆

Sirs:

. . . your magazine is the only one that has made an effort to get the A.R.R.L. functioning for the amateur. I have followed the comments in *R/9* and gladly say that they show the weak spots in the A.R.R.L. clearly. Therefore, keep up the work, and more power to *R/9*!

C. A. MURGATROYD, W5BUV

◆

Salinas, Calif.

Sirs:

I wish to compliment you on your courageous and vigorous fight against selfish commercial interests.

I would like to see more technical dope on superheterodynes.

DONALD C. SMITH, W6GEU

◆

New Westminster, B. C.

Sirs:

. . . *R/9* is a credit to the men who produce it. My best wishes to you all.

L. S. DAVIES, VE5FK

A Compact Condenser Mike Preamplifier

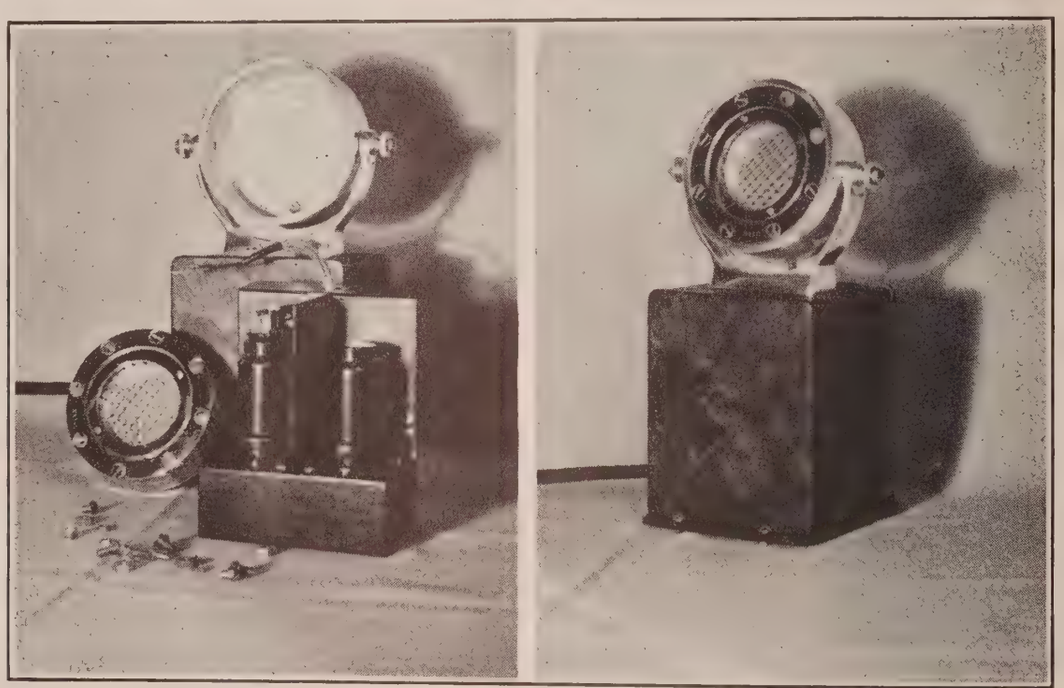
By Fay W. Harwood, W6BHO*

Three years ago W6BHO developed a condenser microphone preamplifier, a.c. operated, with a hum level comparable to battery supply. The performance, simplicity, and inexpensiveness of the amplifier were such that to date approximately 1000 of these preamplifiers are known to have been built. The 1936 version is described herewith, fundamentally the same but twice as compact.

About three years ago when most everyone, including manufacturers, seemed to think that a low-level preamplifier should of necessity be run from a d.c. supply, the author, out of curiosity began "fiddling around" with a.c. tubes in an attempt to build a preamplifier entirely a.c. operated that would have very low hum. From these experiments evolved an amplifier having very high gain and very low hum. No special tubes were used and the amplifier was both simple and economical to build. This amplifier, using a 2A6 and a 56 (6.3 volt tubes were not out yet) worked out so well that requests began pouring in from all over the country for the circuit diagram and constructional details. After sending out several dozen penciled drawings, the diagram was mimeographed and several hundred sent out during the next year or so in answer to requests for the circuit.

The performance of the original amplifier cannot be improved to any great extent, but new developments in parts and tubes allow a more compact and better mechanical design.

In the amplifier seen in the photographs a metal - envelope 6F5 replaces the 2A6 and a 6C5 goes to bat for the 56. Electrically these metal tubes have little advantage except for possibly a very slightly lower hum level, and a little more gain in the case of the 6C5. However, they take up much less room and greatly simplify the problem of shielding. The compactness of the preamplifier is evident from comparison with the microphone head, which is of standard size. The entire two-stage preamplifier fits in a case that once housed a Stromberg-Carlson audio transformer! The interior partitions were constructed from galvanized sheet iron and then given a coat of lacquer to match the case. The mechanical construction is such that all parts in the amplifier are readily accessible; also, very good and complete shielding is provided.



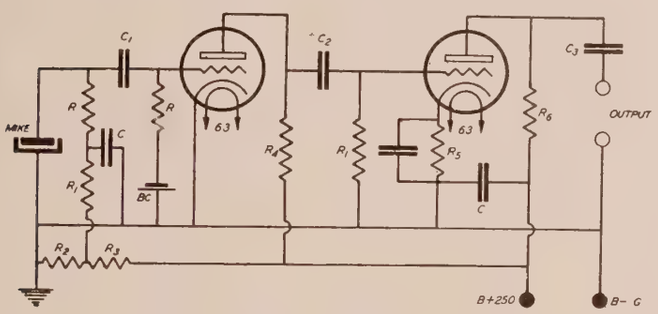
A Mallory bias cell is used for bias voltage on the 6F5. This simplifies the circuit considerably and works out very well in practice. A potentiometer arrangement is used so that the full 250 volts is not applied to the microphone head. This potentiometer system reduces the polarizing voltage to about 175 volts.

*R. F. D. 1, Santa Paula, Calif.

With some heads it is not advisable to apply much over 100 volts of polarizing voltage. This can be taken care of when necessary by changing the ratio of the potentiometer (voltage divider) resistors.

For quiet operation it is advisable to use special "noiseless" resistors. In the second stage the level is high enough that any grade of good carbon resistors will be satisfactory. The shielded lead from the hot plate of the microphone head to the grid circuit of the 6F5 should have *excellent* insulation between the shielding and internal wire. In fact, if the output of the amplifier shows considerable noise and you are sure the microphone head is not at fault, this lead wire is the first thing to suspect.

The output impedance of the preamplifier is low enough that no line coupling transformers will be necessary for distances up to 100 feet. The output is fed to the grid of the first tube in the main amplifier either through a regular inter-stage audio transformer or a 0.1 μfd. coupling condenser. The transformer should be located at the input of the main amplifier if transformer coupling is used. If resistor coupling is used, the 0.1 μfd. condenser should be located at the input of the main amplifier even though there is already one blocking condenser in the output lead at the preamplifier.



Wiring diagram of the compact condenser microphone preamplifier. See text for description of suitable power supply. The paper condensers should be of very high grade (low leakage).
C —0.5 μfd. 400 working volt paper.
C_1—.004 μfd. or larger mica.
C_2—.01 μfd. or larger mica.
C_3—0.1 μfd. paper 400 volt.
C_4—25 volt 25 μfd. electrolytic.
R—20 megohms.
R_1—1 megohm.
R_2—500,000 ohms.
R_3—200,000 ohms.
R_4—250,000 ohms.
R_5—3500 ohms.
R_6—50,000 ohms 3 watts.
BC—Mallory grid bias cell.

If the general mechanical layout of the amplifier in the photograph is followed, no particular precautions are necessary except for shielding the filament leads and making the grid leads as short as possible. The heaters should be grounded (important!) either at the center tap winding on the filament supply or by a center tap resistor if the transformer does not have a filament center tap.

With a condenser microphone head of average gain the output of the preamplifier is sufficient to rattle a pair of phones loud enough to be uncomfortable, with no audible hum provided the power supply filter is adequate. Either a resistance-capacity or inductance-capacity (using high-inductance, low-current chokes) filter may be used, provided it has at least 3 sections and a total of 30 μfd. or more of filter capacity. Three small 50 hy. (or more) 10 ma. chokes, with 8 μfd. electrolytics fore and aft and in between (4 of them) provides a good hum-free voltage source.

◆

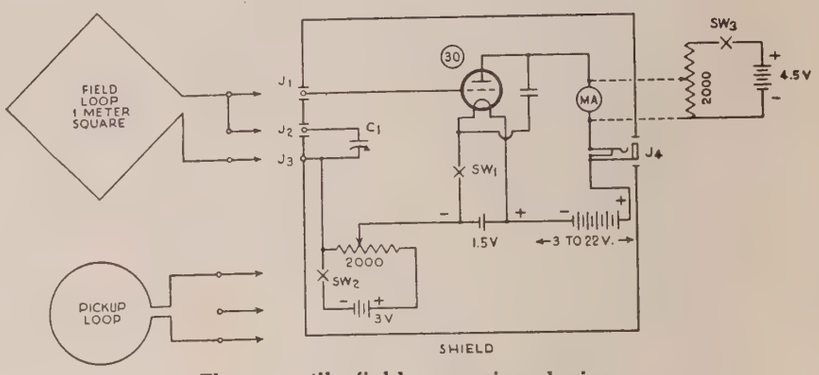
Recently *R/9* explained the use of resistors in the plate leads of an 83 tube whose two halves are being operated in parallel. These resistors serve the purpose of preventing one plate from "hogging" the entire load to the early destruction of the tube. The defect of the scheme is that a 100 ohm resistor consumes some power, and also affects the voltage regulation. Both of these drawbacks can be avoided by another device which is more costly and therefore was not mentioned in connection with the 83 tubes. Now that the 866 price has been lowered we shall certainly see more of these tubes used in place of 83 tubes, and that brings us to our tale.

If a pair of 866 tubes be used in parallel we of course have the same (and more) tendency for one tube to "hog" the load. Now if we eliminate the direct connection between the two 866 tubes (at the plate) and instead connect the two plates by a center-tapped 4 hy. choke of fairly low resistance, we can do all the resistors did, and more, without running into bad voltage regulation and lost power. The ends of the choke go to the paralleled tubes. Better start out with a choke which has two independent windings and try reversing one of them to see which connection gives the best distribution of the glow in the two tubes when loaded with about 400 ma. If you prefer to buy your equipment ready-made there is a new U.T.C. choke for this exact purpose. It was worked up for a new line of amateur transmitters in which 4 type 838 tubes (two r.f. and two audio) demand more current than a single pair of 866 tubes can supply within their rating. With the aid of the balance-chokes a quartet of 866 tubes does the work of a pair of 872 tubes, and without danger to the tubes.

A Simple Field Meter of Many Uses

By Wayne Cooper*

Numerous field-strength meters have been described which are of little use to an amateur because they are too heavy to move around readily, or else so insensitive they require a large antenna, which again harms the reliability. Amateur stations are seldom surrounded by open territory through which one may drive a car carrying a bulky measuring device; on the contrary it is usually necessary to work in territory filled with wires, trees and houses —and part of the job is to get the field-meter *near* these obstructions to discover what they are doing to the field in the way of local losses. On the other hand it is also useful to make measurements of some sort at distances of ¼ to ½ mile to find out if the antenna pattern looks at all as it should at that distance.



The versatile field-measuring device.

Light weight and fair sensitivity are therefore necessary, even if some precision goes overboard. The arrangement diagrammed has met these requirements well. For use in the field a 1-meter-square loop is used. It was discovered early that this gave much better pickup than a "rod" antenna. The directional effect of the loop is an asset, because with it one is able to discover where the signal comes from—the antenna or that power line over there! This is not a joke; it might be found that the power line is actually doing much of the work.

Where the large loop is too bulky or gives excessive pickup it may be replaced by a smaller coil with the *same* terminal arrangement, that is, with 3 plugs so as to pick up the tuning condenser and become a tuned coil. Such a coil can be calibrated as a frequency meter. Where still less pickup is needed an untuned small coil (2 plugs only) is used. This would be used in the vicinity of transmitters, except those of very low power, which call for the tuned coil. When working with a multi-stage transmitter it is better to use low sensitivity and to stay near the stage being worked on, so as to avoid coupling to several stages at once. Harmonics are easily picked up in this way. If there is a load on the transmitter it may be found that the fundamental is being used up by the load while the harmonics seem actually stronger than the fundamental. This is due partly to the strengthening of the harmonic by a tuned circuit resonated to it (in this case the meter we are now talking of).

The field meter should be shielded completely except for the coil, so that pickup comes only from the coil.

The Indicating Meter

The d.c. meter may have a 0-1 milliampere range for use around the station where no great sensitivity is needed. However, even this meter should have a short-circuiting switch and the shorting-switch should never be opened until the tube has maximum bias. A 0-100 *micro*-ammeter costs no more than the usual pair of thermo-couple meters used to tune the antenna. Such a meter gives the field-meter much more flexibility. It can then be used in the field as well as in the station. However, such a meter must be treated with great respect; it should even be short-circuited when the filament is being turned off or on. A convenient dodge in protecting meters by short-circuiting switches is to adjust the resistance of the shorting-switch and its wires so that a full-scale deflection with the switch open is reduced to about two divisions with the switch closed. Then, if the meter moves more than two divisions, *do not open that switch.*

Plate-current Bucking Circuit

In the diagram an auxiliary battery is shown for "bucking out" the plate current through the meter. By running the plate current and the auxiliary current through the meter in opposite directions the total meter current is made very small. This permits starting with a small meter-reading even though there is considerable plate current. The meter then has to measure

*R.F.D. 1, Box 59, Hope Ave., Santa Barbara, Calif.

only the *increase* in the tube's plate current. In portable operation this bucking circuit has been found not worth the extra weight. The fields are not strong at a distance and there is ample meter-scale.

Construction

The diagram suggests that the batteries be inside the shield to prevent stray pickup and to improve portability. The tuning condenser may have the usual capacity, say about 0.0005 μμfd. if the work is to be done in the 3.5, 7, and 14 megacycle bands, or half of that if only the last two bands are to be touched. If the condenser rotor is grounded to the shielding case there will be no r.f. voltage to speak of at the slider of the grid potentiometer, hence no hand-capacity effects to think about. This assumes that the instrument is held from the side farthest removed from the coil, which is possible if the meter is at the back or on top, and the phone-jack and carrying-handle are also at the back.

The .002 μfd. condenser is to bypass r.f. directly from the plate to the filament so that none will appear at the jack or at the bucking circuit if any is used. The tube is to operate as a detector.

Under no circumstances pull the pickup loop out of the jacks when the tube is turned on as this removes the bias from the tube and before it blocks there will be enough of a current surge to endanger a 0-1 ma. meter, and to spell nearly sure death to a 0-100 microampere meter.

Calibration

As it stands the instrument does not give one any figures as to field strength, not even as to relative field strength. When the meter goes up there is more field strength, but one does not know how much more because one does not know whether the detector is linear or not. A calibration in actual field strength is not necessary for most amateur purposes and may well be avoided as a bad job, unless you happen to be inclined toward precision measurements. A calibration in relative field strength is not so difficult provided one happens to have a nice clear place surrounding a more or less vertical antenna, so that one can hope the field dies off as the text books say—according to the square of the distance. The method has been described repeatedly.

EDITOR'S NOTE—Just for luck we shall describe it briefly once more: With a book laid on the key, the time having been chosen for least activity on the band, one carries the field meter out to such a distance that the smallest useful meter-movement is produced when the device is tuned to the transmitter. Let us say this is 2 scale divisions from the off-tune meter reading. It is now necessary to make record of the plate voltage, filament voltage, and grid voltage which are being used. A change in any of them will upset the calibration to some extent. Accordingly a field-meter to be calibrated should have provision for measuring these voltages readily, and an occasional check is advised. Let us say the meter did move two divisions and the distance (measured) to the station was 1000 feet. Now if we come in to 500 feet the field should be 4 times as strong since the distance is halved. If we come in to 250 feet (quarter distance) the field is 16 times as strong, and at 200 feet (1/5 distance) it is 25 times as strong. At 100 feet it is 100 times as strong, and so on. We do not know what the original field is in microvolts-per-meter but we can write down:

For plate volts 22, fil. 2, grid 1.5

Field (relative)	1X	4X	16X	25X	40X	(and so on)
Meter reading	2	8	32	48		(or whatever appears)

Perhaps the "X" had better be left out of line 1 as we have already said "relative."

One can repeat this for another grid or plate voltage and thereby get another range of field-strengths which give readings on the meter scale.

If your final amplifier is operating class C, you can calibrate the field meter by setting it out under the antenna (to get it away from the effect of the buffer stages) and vary the input to the final amplifier, plotting the relative points by assuming that the output of the final amplifier is proportional to the input. If you have any good r.f. meters, you can measure the output of the transmitter directly, in which case it is not essential that the final stage be running class C. This is a lazy man's way of calibration, but just as good or better than running all over 5 acres with a measuring tape. Just adjust the input of the final amplifier until the r.f. meter coupled to the final tank or antenna feeder reads half, or a quarter, and so on. For each output, run out in the yard and note the reading on the field meter, and use it for a point on the calibration curve.

◆

Millisecond Measurements

General Electric has announced an electronic timer for quickly and conveniently giving direct readings in terms of thousandths of a second. The method of determining time is to charge a condenser at a known rate during the interval, and then measure the voltage built up on the condenser. To eliminate, in so far as possible, errors of mechanical devices, the charging of the condenser is controlled by two Thyratron tubes, one to start and the other to stop the current flow. The condenser voltage is measured by a vacuum-tube voltmeter arrangement, using a bridge circuit, so that the condenser charge is maintained during the reading period.

A compact box contains all the necessary equipment with terminals for connecting to the power supply (115 volts, 60 cycles; and 125 volts direct current) and to the device under test. Readings can be taken quickly, as the time values are obtained by a simple conversion of the voltmeter reading.

Self-Excited Oscillators

In the last two years there has been a tremendous growth in the use of high-frequency electricity for various medical and industrial uses. In many cases, amateurs have been called on to design or build medium and high-powered high-frequency oscillators, and many requests have come in asking for an outline of the fundamentals underlying the vacuum tube oscillator together with a discussion of the various oscillator circuits and their relative advantages and disadvantages.

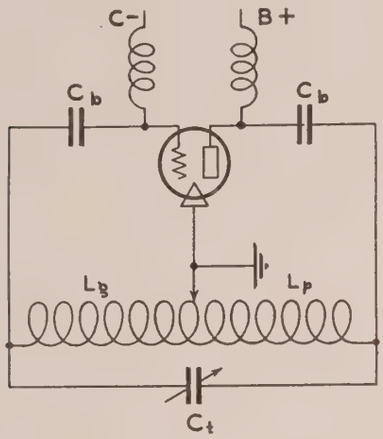


Figure 1
Hartley oscillator. Shunt feed is shown in all circuits in this article to make comparison easier.

The high-powered self-excited regenerative oscillator is practically obsolete for communications purposes in this country, at least for frequencies below 30 mc. The m.o.p.a. type of radio transmitter usually allows a better signal to be radiated at somewhat lower cost than when a self-excited high-powered oscillator is coupled directly to the antenna. However, for portable use, where simplicity and weight are important factors, the self-excited oscillator is still widely used. It should be emphasized that the simplicity of a self-excited radio transmitter does not imply that such a transmitter is cheaper or easier to adjust than the m.o.p.a. type. In fact, the extreme precautions that must be taken to insure frequency stability and a good note in the s.e. transmitter usually make it cost more than an equivalent m.o.p.a. rig. Also, it should be pointed out that the critical nature of the adjustment of an s.e. radio transmitter more than offsets the fact that there are only three important adjustments on any self-excited regenerative oscillator, as against from four to twelve or more adjustments possible with an m.o.p.a. Though there are usually more knobs to twist on the m.o.p.a. transmitter, the principal adjustments are definite, and proper adjustment is always indicated on simple meters. On the other hand, all three adjustments on the self-excited radio oscillator require the use of a trained pair of ears in conjunction with an accurate and properly shielded frequency meter-monitor. The three adjustments essential for good results from a radio oscillator directly feeding an antenna are: frequency, grid excitation, and antenna loading. They will be discussed in detail later.

Operation of Regenerative Oscillators

The function of a vacuum tube oscillator is to deliver a continuous succession of alternating current cycles of electricity. It is simply a special form of alternator, or alternating current generator. It takes energy in the form of direct current plate power and changes it into pulsating plate current. Any pulsating direct current may be considered to be an alternating current superimposed on a smooth direct current. The output coupling device essential to all vacuum tube oscillators is simply a filter to separate the d.c. from the a.c. in order to apply the a.c. component to the load circuit.

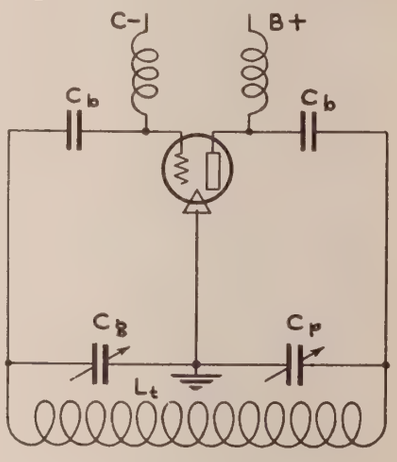


Figure 2
Colpitts Oscillator.

Before analyzing the vacuum tube oscillator it is necessary to understand the amplifier function of a vacuum tube. A vacuum tube amplifies by reason of the fact that a small controlling voltage applied to the grid (control electrode) *releases* a large flow of current through the plate circuit. In this respect a vacuum tube amplifier is exactly similar to the conventional relay in which an energizing voltage applied to the solenoid magnet of the relay attracts the contact-bearing armature, which closes a circuit

where the current flow may be a hundred or more times the current flow in the solenoid energizing circuit. Thus a relay might be said to have an amplification factor equal to the ratio between the control current and the controlled current. The principal difference between the ordinary relay and a vacuum tube relay (amplifier) is that the mechanical relay has only two positions of the controlled current. It is either zero or full on. The vacuum tube amplifier, on the other hand, has an infinite number of intermediate points between zero current flow in the plate circuit and maximum current. Since the vacuum tube also has no mechanical inertia to contend with, it can deal with much faster variations of controlling voltage. The only moving element in a vacuum tube is a stream of electrons which move at a speed determined by the plate voltage. (Approximately 370 miles per second times the square root of the plate voltage. Thus with 100 volts plate voltage, V=370 × 10=3700 miles per second.) At frequencies below about 100 mc. the time of flight of the electron stream does not affect the operation of the vacuum tube and the effect of the grid control may be said to be practically instantaneous.

The amplifying properties of a vacuum tube might be described as follows: A small change

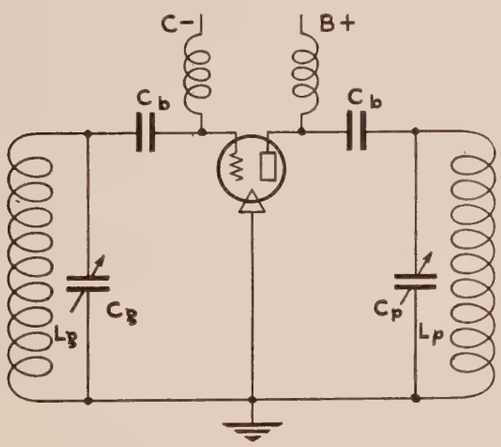


Figure 3
Armstrong (t.p.t.g.) Oscillator.

in grid voltage produces a greater change in plate current than would be produced by the same change in plate voltage.

If the contacts of a common relay are connected in series with the solenoid and a battery, a condition of continuous oscillation will result. In other words we have a simple buzzer. Thus the amplifying properties of the relay are used so that the control element receives energy that is controlled by the contacts, or output circuit of the relay, resulting in oscillation. Similarly, if the plate circuit of a vacuum tube is so connected that some of the energy at that point is fed back to the control grid in proper phase, continuous oscillation will result.

After the vacuum tube is hooked up in a suitable circuit, closing a switch in the plate power supply causes a small surge to be induced in the grid circuit. This surge is amplified and again appears in the plate circuit. This larger surge is again applied to the control grid and

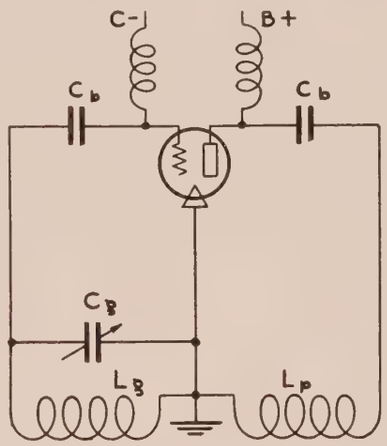


Figure 4
Feed-back Oscillator.

a still larger surge again appears in the plate circuit. This constantly increasing surge keeps repeating itself until its amplitude becomes as large as the tube can handle, at which time the amplitude of oscillation becomes constant. The frequency of oscillation is entirely dependent on the time constant of the circuit. Every circuit contains some capacity and inductance. A capacity and an inductance have a definite time of charge and discharge and the voltages in the circuit can not change faster than the rate determined by the circuit reactance.

Thus the frequency of oscillation is largely determined by the inductance and capacity present in the grid and plate circuits of the vacuum tube oscillator. As the presence of resistance in circuits containing inductance and capacity affects the *apparent* resonant frequency, the tube resistance and the coupled load resistance have a slight effect on the frequency at which the circuit oscillates *easiest.*

As practically every regenerative oscillator has a more or less complex circuit arrangement it will always be found that any given regenerative oscillator *can be made to oscillate at from three to twenty widely different frequencies* with no changes in the inductance and capacity of the associated circuits. However, an oscillator usually oscillates at that frequency where it obtains the most feedback (in other words, where it oscillates easiest). In some oscillators it sometimes happens that there are

two or more frequencies which are equally attractive to the tube. Then the oscillator simultaneously oscillates at all of these frequencies and the unwanted frequencies are described as parasitic oscillations. The most common form of parasitic occurs at a frequency determined by the tank tuning capacity in conjunction with the inductance of the leads to the tube elements. The frequency of this type of oscillation is

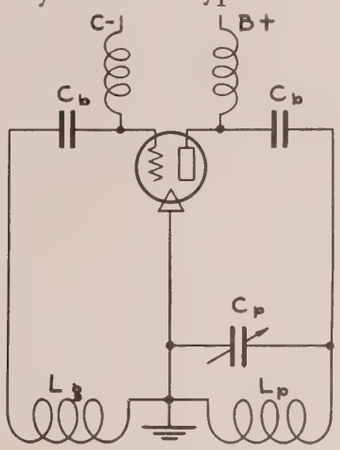


Figure 5
Reversed Feed-back Oscillator.

usually above 30 megacycles. The use of too large a grid leak sometimes allows an oscillator to oscillate at a very low frequency when the leak resistance is too high to allow the grid blocking condenser (C_{gb}) to discharge fully between each cycle of the desired oscillation frequency. When this occurs the oscillator is said to be super-regenerative, and this phenomenon is widely used in ultra-high-frequency receivers.

Choice of an Oscillator Circuit

The ideal oscillator circuit would have three smooth and independent controls: 1) frequency control; 2) load control; and 3) excitation control. All three of these factors must be independently adjusted, regardless of the use to which the oscillator is to be put.

The ideal oscillator also must use the inherent tube capacities to best advantage, which immediately indicates that the choice of the best circuit depends on the frequency at which it is to be used.

The ideal oscillator would have the three controls free from interlock. In other words, any one control could be adjusted without necessitating readjustment of the other two. At the present time there is no such oscillator circuit, but some are materially better than others in this respect.

The ideal oscillator, for any purpose, must use as few parts as possible, in order to keep the cost down.

Some oscillator circuits are easier to stabilize than others. Practically all oscillator circuits are capable of about the same output, frequency stability, and plate efficiency when properly designed, built, and adjusted.

Many unusual oscillator circuits have been devised to get around existing circuit patents and have no other advantage.

It is necessary to keep these factors in mind when analyzing the following oscillator circuits.

Types of Regenerative Oscillators

There is no entirely satisfactory system of classifying regenerative oscillator circuits. Perhaps the best way is to classify them by the feedback coupling method.

As there are only two methods in use, all regenerative oscillators might be said to be modifications of the Hartley (inductive feedback) or the Colpitts (capacitative feedback). As practically all oscillators actually use a combination of the two types of feedback coupling, any oscillator should be defined by that type of coupling through which *most* of the feedback energy passes. This lends difficulties because two oscillators having the same identical circuit but operating on different frequencies might have to be described as totally different types of oscillators. In fact, it is entirely possible for an oscillator to turn from a Hartley into a Colpitts merely by tuning the tank con-

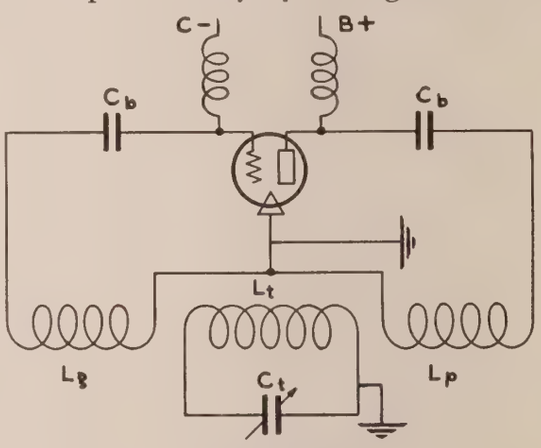


Figure 6
Meissner Oscillator.

denser and raising the frequency of oscillation, if the above definition is strictly adhered to. Therefore, only the simple Hartley and Colpitts oscillators will be described as such, while the more complex oscillator circuits will be classified by the names of those having had the largest part in their development.

However, the parentage of each oscillator, traced back to its Hartley or Colpitts ancestor, will be indicated in each case.

This part of the discussion will only briefly outline the major features of ten different oscil-

lator circuits, bearing in mind, of course, that eight of the oscillators are related to one or both of the other two. Later, each of these oscillators will be analyzed in detail and their relative advantages and disadvantages will be discussed.

Notes on the Circuit Diagrams

For the sake of simplicity, all the circuits are shown as using shunt feed of the d.c. plate and bias voltages. This avoids confusion as all of the circuits can be shown with shunt feed while not all of them can be shown with series feed. It is not implied that in a practical oscillator series feed should not be used wherever it can be conveniently managed.

The abbreviations are standard throughout.

Lg—	Grid inductance
Lp—	Plate inductance
Lt—	Tank inductance
Lf—	Feedback inductance
Lf1—	Primary of feedback transformer
Lf2—	Secondary of feedback transformer
Cg—	Grid tuning condenser
Cp—	Plate tuning condenser
Ct—	Tank tuning condenser
Cgb—	Grid blocking condenser
Cpb—	Plate blocking condenser
Cn—	Feedback neutralizing condenser
Cf—	Feedback or feedback adjusting condenser
Cgp—	Grid-to-plate capacity (Tube)
Cgf—	Grid-to-filament capacity
Cpf—	Plate-to-filament capacity

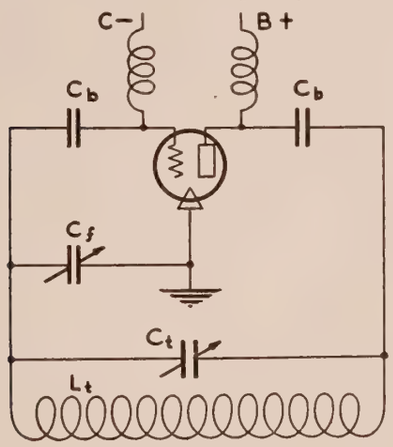


Figure 7
Ultraudion Oscillator.

The Hartley Oscillator

In figure 1 is shown the fundamental Hartley oscillator circuit. The grid and plate are connected to the extremities of the tuned circuit. As L_g and L_p are parts of one tightly coupled coil, the relative a.c. grid and plate voltages are determined entirely by the placement of the variable cathode (ground) tap on the coil. Thus moving the cathode tap on the coil over toward the plate end of the coil will cause a larger part of the a.c. tank voltage to be applied to the grid, increasing the a.c. grid excitation. The frequency is determined by the tank coil L_g,L_p, in parallel with C_t. The Hartley is widely used at frequencies where the interelectrode capacity of the tube does not permit the feedback of large amounts of energy.

The Colpitts Oscillator

Figure 2 shows the fundamental shunt-fed Colpitts circuit. It will be seen that it is very

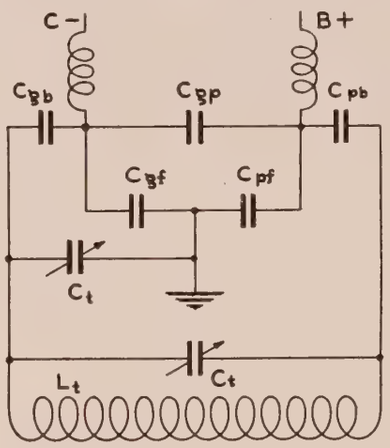


Figure 7-A
Circuit-capacity study of Ultraudion circuit.

similar to the Hartley but that the a.c. tank voltage is divided between the grid and plate by what amounts to a tapped tank condenser, instead of a tapped tank coil. The cathode tap goes to the junction of C_1 and C_2 and the a.c. voltage drop across each condenser varies inversely with their capacity. Thus as the capacity of C_p is increased (or the capacity of C_g decreased), more of the available a.c. tank voltage is applied to the grid, increasing the grid excitation. This type of Colpitts has a smoother control over the feedback than the Hartley shown in figure 1 and also allows the use of an untapped tank coil. However, two tuning condensers are necessary. Note that the rotors of the Colpitts tuning condensers can be grounded, while both sides of the Hartley tuning condenser are above ground.

Thus the Colpitts oscillator would be bothered less with hand capacity. However, it is harder to apply series feed of the d.c. plate voltage to the Colpitts as no part of the tank coil is tied to an r.f. ground. This type of Colpitts is widely used at the lower frequencies where the plate-to-grid capacity of the tube is not enough to allow satisfactory oscillation without external feedback.

The Armstrong Oscillator

This is sometimes called the "tuned plate-tuned grid" oscillator and is shown simplified in figure 3. The source of feedback is not

apparent at first glance; it consists of the plate-to-grid capacity of the tube. The feedback is not directly variable in this type of oscillator, but its effect on the a.c. grid voltage is varied by detuning the grid-tank L_gC_g away from resonance in order to reduce the excitation. The tuned grid-tank is often replaced by a coil that

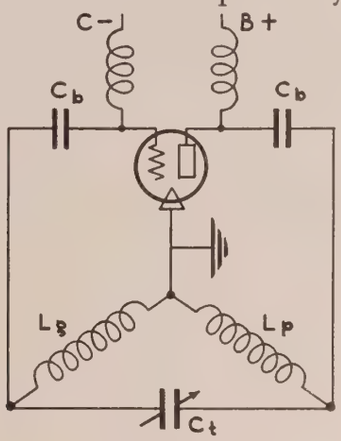


Figure 8
Simpson Oscillator

is resonated with its distributed or self-capacity at a value of impedance that allows proper grid excitation across a narrow band of frequencies determined by the plate-tuning capacity C_p. This type of oscillator is called the "TNT" and is similar to figure 5, though inductive coupling between L_g and L_p must be avoided. The grid coil is rather critical for optimum excitation and should not be considered as untuned, but as semi-resonant in all oscillators that have to deliver any appreciable amount of power to a load. Of course liberties may be taken with the grid coil if the oscillator need not supply much power beyond its own grid losses, as in a receiver or beat-oscillator.

The Armstrong oscillator is most useful at the higher frequencies as it makes use of the interelectrode capacity of the tube. It should not be used when the frequency or the plate-to-grid capacity of the tube does not allow sufficient grid excitation to be obtained for stable oscillator operation.

The Feedback Oscillator

This type of oscillator is shown in figure 4 and is sometimes called the "tickler" or "tuned-grid" oscillator. It really amounts to a Hartley oscillator where the portion of the tank associated with the plate of the tube is untuned. It is entirely satisfactory for receiver and other applications where large amounts of power output are not required, but the straight Hartley is more desirable for high power output. Note that fairly close inductive coupling is required between L_g and L_p. If there is no inductive coupling between these two coils the circuit becomes a modification of the Armstrong oscillator.

The Reversed Feedback Oscillator

The oscillator circuit shown in figure 5 is sometimes called the tuned-plate oscillator and is quite similar to the circuit of figure 4 in its operation. The feedback occurs through the inductive coupling between L_p and L_g and the feedback is adjusted by either changing the coupling between L_p and L_g or else by varying the number of turns on L_g. If there were no inductive coupling between L_p and L_g the circuit would become the TNT modification of the Armstrong oscillator. This circuit is not used for high power output.

The Meissner Oscillator

This useful modification of the simple Hartley oscillator shown in figure 6 somewhat isolates the tuned frequency-determining circuit from the oscillator proper. This keeps d.c. potentials off the tuned circuit and allows one side of the tuning condenser to be grounded. The feedback is adjusted by varying either the coupling or the turns on either the grid or plate coils. This oscillator is seldom used where high power output is required.

The Ultraudion Oscillator

The deForest ultraudion circuit (figure 7) has probably caused more controversy over how it works than all the other oscillator circuits

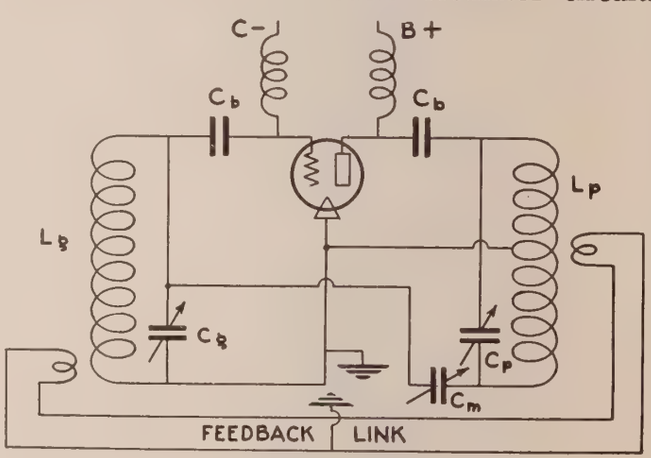


Figure 9
External Feedback Oscillator.

put together. Thus your reporter respectfully submits his theory of ultraudion operation. The Ultraudion can be considered a Colpitts which uses the plate-to-filament and the grid-to-filament inter-electrode tube capacities to divide the a.c. tank voltage between the grid and plate. This may be more evident in figure 7A. Neglecting the blocking condensers C_{gb} and C_{pb} the capacities C_{gf} and C_{pf} are effectively in series across the tank L_tC_t. Thus the a.c. voltage will divide in inverse proportion to the two capaci-

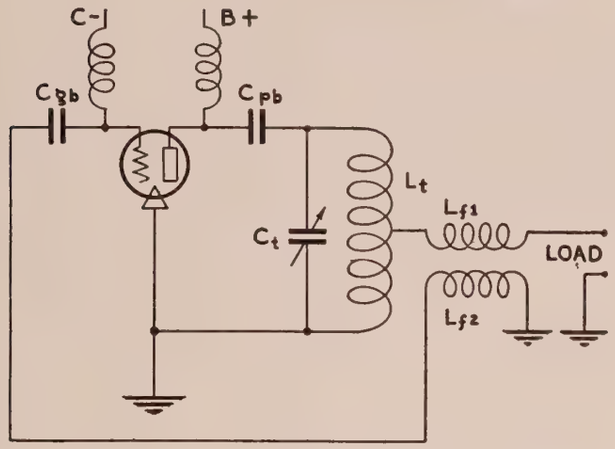


Figure 10
Hawkins Special Diathermy Oscillator

ties. C_f is added effectively across C_{gf} as an external control of the grid excitation. The plate-to-grid capacity of the tube serves no useful purpose except to make the problem of accurately analyzing the feedback extremely difficult. The oscillator is principally useful with a tube with high interelectrode capacities when used at a very high frequency. As the condenser C_f has only a limited control over the grid excitation, the d.c. plate voltage, grid bias, and load must all be adjusted as C_f is adjusted in order to get optimum grid excitation.

The Simpson Oscillator

The Simpson Oscillator is shown in figure 8 and differs from the Hartley only in the fact that there is no inductive coupling between L_p and L_g. L_p and L_g are in series and resonate with C_t at the desired frequency. As the a.c. voltage across C_t is 180 degrees out of phase, the grid and plate voltages are also out of phase and the condition for oscillation is realized. However, this type of oscillator is almost never used single-ended, but in push-pull. The details of this most unusual oscillator will be discussed later.

The External Feedback Oscillator

This type of oscillator (figure 9) can use either capacitative or inductive feedback. It merely consists of an amplifier neutralized to prevent it from acting as an Armstrong oscillator. Then some of the output is coupled back into the grid circuit through a transmission line. The feedback is varied by adjusting the coupling to the feedback link, or transmission line. The oscillator shown in figure 9 happens to use inductive coupling. If a selective filter circuit is used in the transmission line a high degree of frequency stability can be obtained. This oscillator might have been suggested by the Meissner oscillator. It is not widely used at the present time. The feedback link often consists of a selective resonant line.

The Hawkins Oscillator

This oscillator (figure 10) has also been termed the "load driven oscillator". In all of the oscillators commonly used the grid excitation falls off as the loading on the oscillator is increased. This is due to the fact that the grid excitation in most oscillators is proportional to the a.c. plate voltage. As the load is increased the a.c. plate voltage decreases, which causes the grid drive to decrease. In the Hawkins oscillator the grid drive is proportional to the *load current*, not the a.c. plate voltage. Thus as the load current through L_{f1} increases, the a.c. grid voltage across L_{f2} *increases,* which increases the grid excitation to the oscillator.

This oscillator is principally used in diathermy oscillators where widely varying loads are encountered. This circuit keeps the tube from drawing too much grid current when lightly loaded and too little grid current when heavily loaded. It also allows the use of a cheaper plate tank condenser as the a.c. plate voltage does not go way up when the load is removed from the oscillator, due to the improved output voltage regulation. Too much load cannot stop this oscillator from oscillating, as it often does with the conventional methods of feedback. This circuit has practically no advantages for communications use.

◆

Crystal Lock Circuit

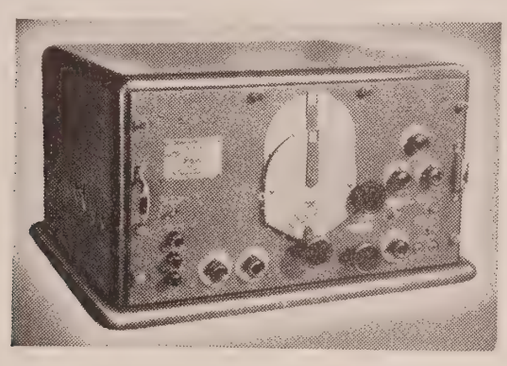
W9AF describes a variation of the "crystal lock" circuit, an old idea that can be put to work in many forms. His method is to tie the crystal across just enough turns of the grid tank of a "TNT" oscillator that the crystal takes control. The grid turns should first be adjusted so that with the crystal out of the holder the oscillator oscillates very weakly at or near the crystal frequency (the proper frequency being obtained by adjustment of the plate tank condenser). When taking the crystal out of the holder for preliminary adjustment, place a piece of cardboard approximately the same thickness as the crystal between the electrodes. Do *not* pull the holder out of its receptacle, as this will change the capacity across the coil. One side of the crystal holder should go to the "cold" point on the coil, and adjustment of turns be made with the other connection from the crystal.

◆

In England, a number of stations are licensed for dummy antenna operation only. These transmitters are assigned the only three-letter G calls.

The R.C.A. AR-60 Commercial Receiver

[This article is based in part on a limited test of the receiver described, by a member of the RADIO Technical staff. Charts and diagrams referred to in the text but not appearing with the story will be found in the offset section of the magazine.]



The AR-60 receiver in table-top case. This is the 80 pound form called AR-60-S.

In a commercial receiver it is necessary to provide extreme permanence against the effects of vibration, heat, cold, and moisture—not to speak of those ship-board radio rooms in which the atmosphere at times consists mainly of corrosive funnel-gasses. This calls for a very heavy chassis and panel, an exceptionally sturdy tuning gang-condenser, and corrosion-resisting painting or plating of all metal parts capable of receiving such treatment. It calls also for especially good impregnation of all windings, for sturdy adjustment-locks, and for an open construction to make repairs possible. All this adds up to a large, heavy, (and costly) receiver. Whether the weight and cost are justified depends upon the service.

General Description

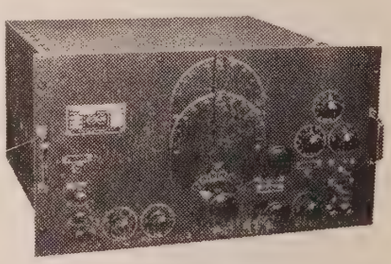
Like most recent receivers, this one employs the superheterodyne circuit with a signal-frequency tunable pre-amplifier and pre-selector. In this case there are two t.r.f. stages on the higher-frequency bands (25.0 - 15.2 megacycles, 15.2 - 9.25 mc., and 9.25 - 5.65 mc.), but one stage is switched out for the lower-frequency bands (5.65 - 3.63 mc., 3.63 - 2.29 mc., and 2.29 - 1.50 mc.), in which the gain is inherently better, and the image-suppression also inherently better, for well-known reasons. One is a trifle disappointed to find that the territory from 25 mc. to around 80 mc. has been omitted, but one must admit that for commercial point-to-point communication a specialized receiver for those frequencies is a better bet. The i.f. amplifier has three stages, the third of which is provided by the pentode section of a 6B7 tube, whose diode section serves in the familiar manner as a detector, and of course as the source of the a.v.c. voltage which is fed back to the r.f. and i.f. amplifiers. So-called "delayed" automatic volume control is provided by a 12 volt bias on the detector, which holds off the a.v.c. action until a signal's carrier exceeds 12 volts at the diode detector. The manufacturer states that this corresponds to about 1 microvolt at the receiver's input terminals.

For signals having low modulation it is desirable to have considerable audio gain. This receiver provides two audio stages. The first is the triode section of a 6F7, whose grid is resistance-coupled to the diode detector, and whose plate is resistance-coupled to a type 41 output pentode. The manual volume control as usual forms a part of the resistance couplings.

Beat note reception is secured by using the pentode section of the 6F7 as a heterodyne oscillator, electron-stream-coupled to the final i.f. stage.

So far this story has said "as usual" and "customary" until one wonders if the AR-60 is anything besides a heavy amateur-type receiver. We shall now turn to the peculiarities of the receiver.

The overall gain of a receiver is necessarily large if good design is applied to 7 stages of r.f., i.f. and audio amplification. We found



The rack-mounting form, called AR-60-R.

R.C.A. very shy in regard to a definite sensitivity statement for the somewhat amusing reason that the truth would look bad alongside of some—shall we say "optimistic statements"? The instruction book makes the obviously conservative statement that 6 milliwatts of audio output can be produced by a 2 microvolt "or less" signal modulated 30% at 1000 cycles and applied through a 300 ohm dummy antenna. In a recent issue of *R/9*, Mr. Glenn Browning has in effect agreed with this same feeling by arguing that unless one knows something about the *noise* output it is rather useless to talk about

TABLE I

Band No.	*Noise Equiv. (c.w.) (Microvolts)*	*Image Ratio*	*Band Spread Range (kc.)*	*Frequency (kc.)*	*% Overlap*	*Stability (Parts per million per %)*
1-LF	.26	30,000	28	1430	4.7	0.7
1-HF	.22	14,600	150	2360	4.8	2.0
2-LF	.21	10,800	45	2250		0.9
2-HF	.17	3800	200	3720	6.1	2.7
3-LF	.20	3000	80	3500		1.4
3-HF	.15	1050	340	5820	5.3	3.7
4-LF	.18	172,000	110	5520		1.3
4-HF	.17	22,000	550	9725	8.3	1.0
5-LF	.22	25,400	175	8950		1.0
5-HF	.20	3000	975	15,750	5.6	3.3
6-LF	.33	5700	350	14,900		2.2
6-HF	.23	930	1500	26,050	4.2	6.4

sensitivity—at least where there is enough sensitivity so that one runs into a noise-background problem. Both the R.C.A. objection and the Browning-Tobe objection center around the fact that there is such a thing as a receiver which makes so much noise of its own that it can turn out nearly standard output *with no input at all*! It then takes only a very little additional input to produce I.R.E. standard output and one gets a misleading sensitivity-figure. The I.R.E. method is therefore hard on those receivers which have been designed for low noise level. In passing it is fair to explain that this isn't exactly the fault of the I.R.E. The method was set up in the days when receivers had so little sensitivity that the noise level wasn't reached. Of course it is now time for the I.R.E. to think it over again and consider some method which states both noise and signal output, or which states the net signal output, after noise is subtracted.

However, we wander. The topic was the AR-60 sensitivity. While anyone familiar with receivers can come pretty close to making a useful guess from the statements already made, it is more informative to take signal-to-noise data from the instruction manual accompanying the receiver. In one of the curve-sheets, reproduced in the offset section, there is a statement of the "noise equivalent." This means that for the different settings of the antenna-coupler one will get a noise-output as great *as would be the signal-output* if a signal-input of the voltage shown by the curve were being applied to the input terminals. In other words this curve shows the actual noise coming out of the receiver under typical operating conditions, and shows what the incoming signal has to override. Just take a look at the way the curve "squinches" down below a microvolt for about ½ of the antenna-coupler's range, and recall that this is the coupling-range normally used. Here is something worth while, not only in performance, but also in a new sort of information provided by a manufacturer.

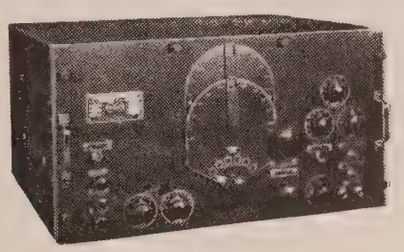
Antenna coupling has been mentioned several times in the last paragraph. It is, as suggested, provided through an r.f. transformer having one winding movable and panel controlled. The other winding is fixed in position and between them there is a static-screen. The antenna winding is subdivided so as to allow connection to ordinary antennas or to lines with an impedance in the range of 50 - 500 ohms. As one coupler cannot cover the frequency range to advantage there are two such couplers, with switch-selection of the proper secondary, but with the primaries permanently in parallel and prevented by design from interfering with each other.

Tuning

Tuning has already been touched upon. It is due to a very massive cast "bathtub" in which resides a Hammarlund special tuning condenser of 4 sections. The main sections are on one shaft, driven by a "fishline" 9/1 reduction drive and reading on the lower one of the two dials by means of a fine wire in the window of the broad pointer. A similar pointer and drive, and the upper dial, are connected with

the smaller "tuning spread" 4-section condenser built into the same bronze bathtub. Like other such dual-tuning arrangements, this system requires two readings to be recorded for each station.

The selectivity obtained in a sample test by the manufacturer is shown in figure 2. The sharper curve is for the "crystal switched in"



The plain table-top type AR-60-T.

condition, with the crystal-bridge balancing condenser set for minimum background noise (high selectivity).

Noise Filter

The output transformer is provided with a primary-shunt condenser. When this is switched on, the higher audio pitches are dropped out to lessen noise. While this was tried in the listening tests one cannot offhand tell whether one would like to "live with" such a device. The idea seems promising for phone reception where the main thought is to get the sense of the conversation, though a normal tone-control would appear to do the same thing, perhaps more pleasantly because of its variability.

What — No Loudspeaker?

Despite the 41 output tube this receiver is not intended to feed a big dynamic speaker. For the sake of power economy when worked with batteries, and also for the very much better reason of low noise level, the voltages on plates and screens have been kept down and the grid biases fairly well up. As a result the 41 does not deliver materially over ½ watt to the best load, which is 600 ohms. One may work into a transformer whose secondary feeds a line going to a remote amplifier, or the transformer may work into a magnetic or other low-demand speaker, but very commonly headset listening will be encountered, and two jacks in parallel are provided. Of course a high-impedance headset is badly mismatched, but ½ watt is a few hundred times the required headset power so that is no matter to worry over.

The advantage of this modest use of the tubes is that the receiver takes but 35 watts from an a.c. line, or when used on batteries requires 2.8 amps at 6 volts for filaments and only 40 ma. at 135 volts for plates and screens. The set will work on 90 volts of B battery satisfactorily.

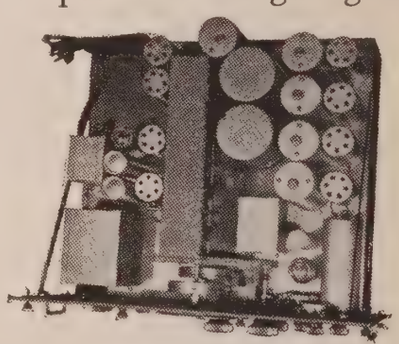
Station Provisions

Where the receiver is to be used in a c.w. station it must be protected against the transmitter's signal.

The receiver is accordingly provided with keying relay terminals which may be used either to short the receiver output when the sending key is down, or else to disable the r.f. and i.f. stages. Protection against the frequency-shifts of the first (translator) oscillator due to line-voltage changes is offered by a gaseous-conduction (neon) tube connected across a portion of the B supply in the old familiar manner of a few years since. A "½ watt" neon lamp minus its ballast resistor can nicely be grafted onto other receivers which need such protection, the plot being to have the glow cover only a part of the plates of the lamp when the voltage is down, so that the lamp can take more current and limit any rise of voltage. B batteries of course need no ballast lamp.

Stability

This gets one back to the matter of stability, on one meaning of which the last column of table I gives a pretty complete story. This column of figures gives the frequency-shift of the first (translator) oscillator when the line voltage is changed from 100 volts to 120 volts, as might happen when the key was let up in a station with poor line voltage regulation. As



Interior view of the receiver. Note the long cast-bronze condenser casing.

to adjustment-drifts, the next-to-last column shows that there are liberal overlaps to allow for any such contingency, even though modern air-condenser trimmers and well-made coils decrease the probability. The 72 pound construction of the set should also have a bearing on the matter of stability. If you don't care for rack-mounting there is a table-top cabinet which brings the weight up to 80 pounds and looks as if it were safe against everything but major catastrophies.

A Simple Tower for Simple Folk*

By The Mayor of Moss Landing**

Whether you live in the city and have no room to run guy wires, or live in the country and don't want guy wires anyhow because of power absorption, this guyless tower is just "what the doctor ordered." The cost of the tower may be kept surprisingly low by following the instruction and advice of "The Mayor."

The 75-foot sway-brace girder tower at W6DDS seems to catch the eye of nearly all the hams that come by this way, and though all of them express a fond desire for such a tower, they seem to think that the construction is too difficult and expensive. With the aid of Mae (not West, but Mrs. DDS), I have built six of these towers at an average cost of less than $8.00, and have found that the Whiteman Brainless Method (not copyright U.S. Patent Office) certainly is a boon to the ham with a small purse.

The materials required for the tower proper are as follows:

12—2″ x 2″ x 20′ (or 1″ x 3″) pieces of *straight-grained* Oregon pine for uprights, rough, unfinished (weathers much better than finished lumber).

2—12′ pieces of whatever material is used above, for "end splices" (will be described).

2 or 3—Bundles of "car strips." These are used for loading vegetables in freight cars. They must be rough and tough, *not* finished.

4—Old railroad ties for ground anchor (10c each here).

5—Pounds of best heavy *galvanized* shingle nails obtainable (rough), or 582,701 (+ or —) nails in case you don't trust the scales.

1—Piece 4″ x 4″ x 20′ for extension (optional). Sets down inside top of tower about 6 feet, adding 14 ft. to height.

1—Bunch of large size assorted nails and wood screws.

2—"Barn door" hinges.

1—Gross 30 penny nails for "teeth" in redwood base posts, so posts will hold in concrete anchors.

1—Sack of cement for making concrete with which to anchor foundation posts.

1—Dozen muzzles or gags to put on spectators and helpers when tower is being raised. Jaw bone adds 100% to the weight of tower.

1—Dose good common horse sense to be used in construction and erection of tower. Otherwise no brains required.

*No Brains required, just elbow grease and horse sense.

**Tom Whiteman, W6DDS, Moss Landing, Calif.

If you can't pick up 1x3's or 2x2's after dark when the man isn't looking (better take a flashlight so you can pick out the best vertical grain lumber), then the cost of the tower will be increased a bit. Also, if you can't anchor the base of the tower in cement as will be described, it will be necessary to invest $5 or $10 extra in guy wires and strain insulators.

Splice the 20 foot sections as shown in figure 3 so that you have four 60 foot sections. Lay two of them flat, with splices turned in, so that they are exactly 4 feet (or whatever you choose for base dimensions) apart and about 15 inches apart at the other end. Start at the bottom and nail on the girders. Drill the strips with a drill slightly smaller than the nails if you have trouble with splitting. If you want to save this work of drilling the nail holes, put the strips in water about 3 weeks before you start construction and let them soak. Go right on up with the girders, keeping the space inclosed by the girders as square as you can. Go up the uprights the same distance the last girder is long. That will keep things square. Save the scraps; if they are over 15 inches long they will fit further on.

The strips used as sway braces should be laid across the uprights as shown in figure 3 and sawed to fit, as the angle will change as you go up and that is the only way to get them right. The sway braces are *not* nailed over the girders, but are nailed to the upright strips, having first been sawed to butt up against the adjacent girder. Put three nails in each end of the car strips, both sway braces and girders.

To make the second side, lay the two remaining 60 foot uprights over the two on the finished side, and use the first side as a template for the second. Be sure to duplicate any mistakes you happened to make on the first side, and they will hide themselves when the tower is completed. By using the first side as a template, only hammer, saw, and nails are required, and much time is saved.

When you have two sides finished, stand on end and start at the bottom with girders as was

done on the first side. Keep all jaw-bone specialists away at this stage, as you are sure to be very sorry that you started the danged thing. By all the sacred Ohm's Laws, keep away all carpenters and anyone with brains or no backbone. Don't hurry or worry; it will still look okay if you don't use a square or rule, and you have until 1938 to finish the job. When the third side is finished, nail a couple of temporary cross braces across the open side before trying to turn the assembly over. When the fourth side is finished, you can put the 4 x 4 extension in the top or leave it off as you wish. The tower should now be cross braced (from diagonally opposite uprights) with either wood strips or wire with turnbuckles to keep it rigid. It should be braced this way about 20 feet from the bottom and again about 20 feet from the top.

It is very important that rough lumber and rough, galvanized nails be used. Not only is the rough lumber cheaper, but it weathers much better, and a single coat of paint will last as long as the tower (a good many years).

The paint should be made up from ground metalic and 2d grade linseed oil. The result is a paint that costs but a fraction of "store-boughten" paint and it lasts much better. It takes a little longer to dry, but you can be making the foundation for the tower while the paint is getting dry. If you soak the car strips to keep them from splitting when nailed, let the tower weather for a few days to give the strips time to dry out before applying paint.

The four redwood (pine will rot quickly) railroad ties are used for a foundation as shown in figure 1. Be sure the four posts are set the right distance apart and in a square; otherwise the base of the tower will not fit the posts properly. Drive the 30 penny nails into the bottom two feet of each redwood post, letting each nail stick out about two inches. This gives the post a good bite in the concrete that is poured around each one. Remember when making the concrete that the bigger the rocks, the less cement is required. Of course there should also be enough smaller rock or gravel to fill in the spaces between the large rocks. That way but little cement and sand is needed. If you want to save on cement, do it by using more rock, but *not* more sand. Too much sand and the concrete is weakened.

After each hole has been filled for two feet or so with concrete and the concrete has started to harden, the hole may be filled the rest of the way with common everyday dirt. If the holes were 18 inches or more in diameter down where the concrete is, it will take a locomotive crane to pull up the posts after the concrete is hard and the dirt around the posts has settled. Tamping the dirt as it is filled in helps hurry up the strengthening process. But don't tamp unless the concrete is allowed to "set" first.

The tower at W6DDS has stood several winds of gale intensity (right off the ocean with no mountains in between) with no guys whatsoever, and the foundation as described above is set in "muck and mud," being located right on the edge of a slew. A set of guys were later put on the tower, but not because they were really needed. The tower misses the nearest of a set of intra-city telephone wires by just three inches, and the phone company got nervous every time a good wind blew. To pacify them, the guys were put on. But they hang quite loosely, taking no strain at any time, and might just as well be off for all the good they do. If the foundation is made as described, the tower will not need a flock of "antennas" going in every direction to hold it up in a wind, which is the case with some so-called guyless towers we have seen. The wind and antenna pull may all be in the same direction, and with 60 m.p.h. of air going by the tower still will stand up and "take it." But if you are too lazy to make the above foundation and have no appetite for digging 8 foot holes, be sure that the tower is guyed well in at least one place above the center. And use *strain* insulators; otherwise you will have pieces of tower all over the yard when an insulator gives way.

Raising the tower is not the job it might first seem. With the "derrick" pole shown in figure 2 the resultant pull on the top of the tower is in a favorable direction even when the tower is near the horizontal. The posts to which the hinges are fastened should be carefully placed (they may be pulled up after the tower is raised; two feet in the earth is far enough) so when the tower goes up the corners of the base will fit accurately over the four redwood foundation posts that have been imbedded in cement (if you want the tower guyless). After the tower is up and made fast to the foundation you can shinny up the tower and untie the wires used for guiding the tower on the way up. Three may be tied *around* the tower (not around each upright) about 50 feet from the foot of the tower and one used for hoisting the tower with the other two as side-

[*Continued on Page 98*]

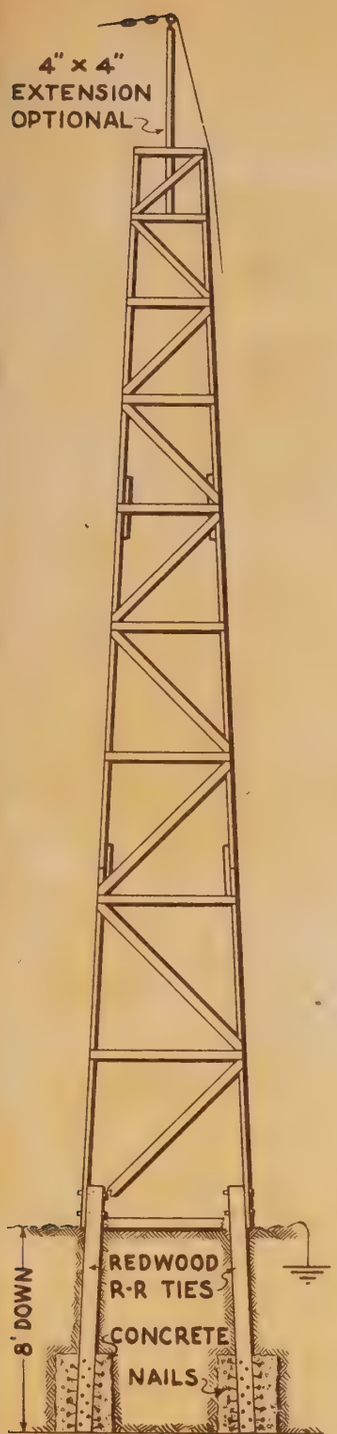


Figure 1

The foundation (four redwood posts sticking out of the ground a little ways) to which the base of the tower is anchored should be embedded in concrete as shown above and described in the text.

THIS TOWER
IS EASY 2
BILD-NO
BRAINS
REQUIRD

SINED-
"THE MAYOR"
-WOODS-

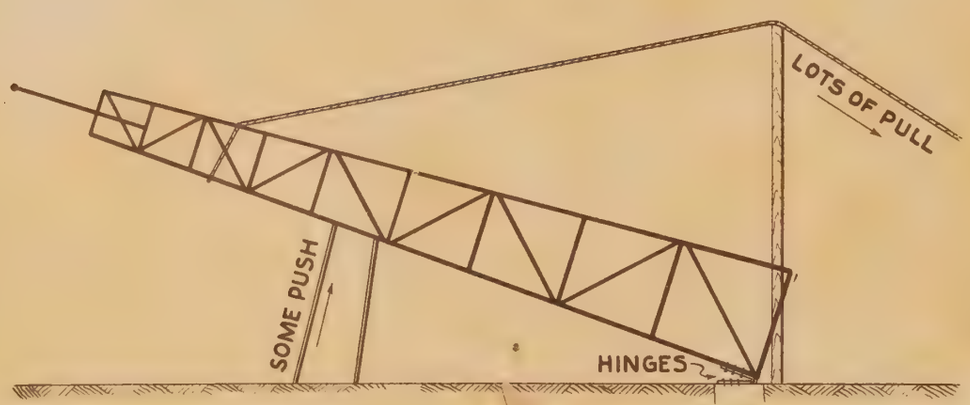


Figure 2

Raising the completed tower is not especially difficult when the above method is used. The hinges should be fastened to heavy stakes in the ground so placed that the base of the tower will "fall into place" on the foundation shown in figure 1 when the tower is raised. After the base is made fast, you can climb up and untie any ropes or wires used to steer the tower while being raised.

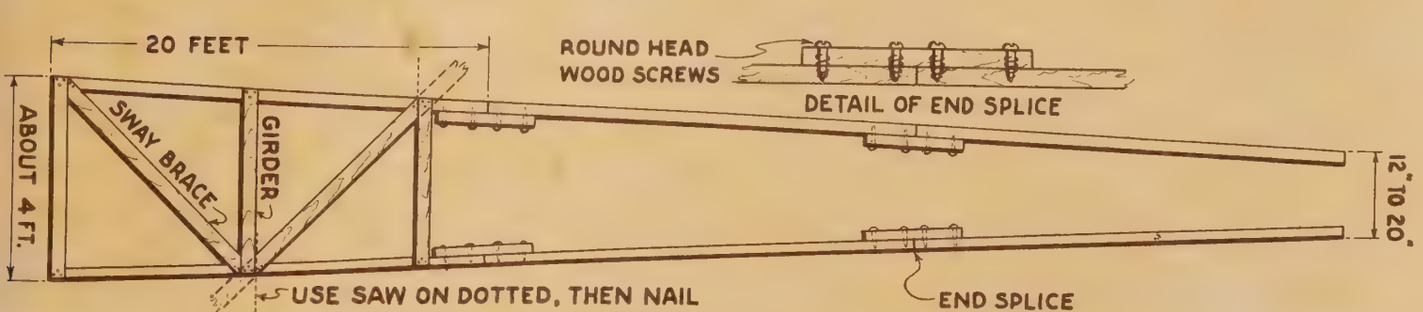
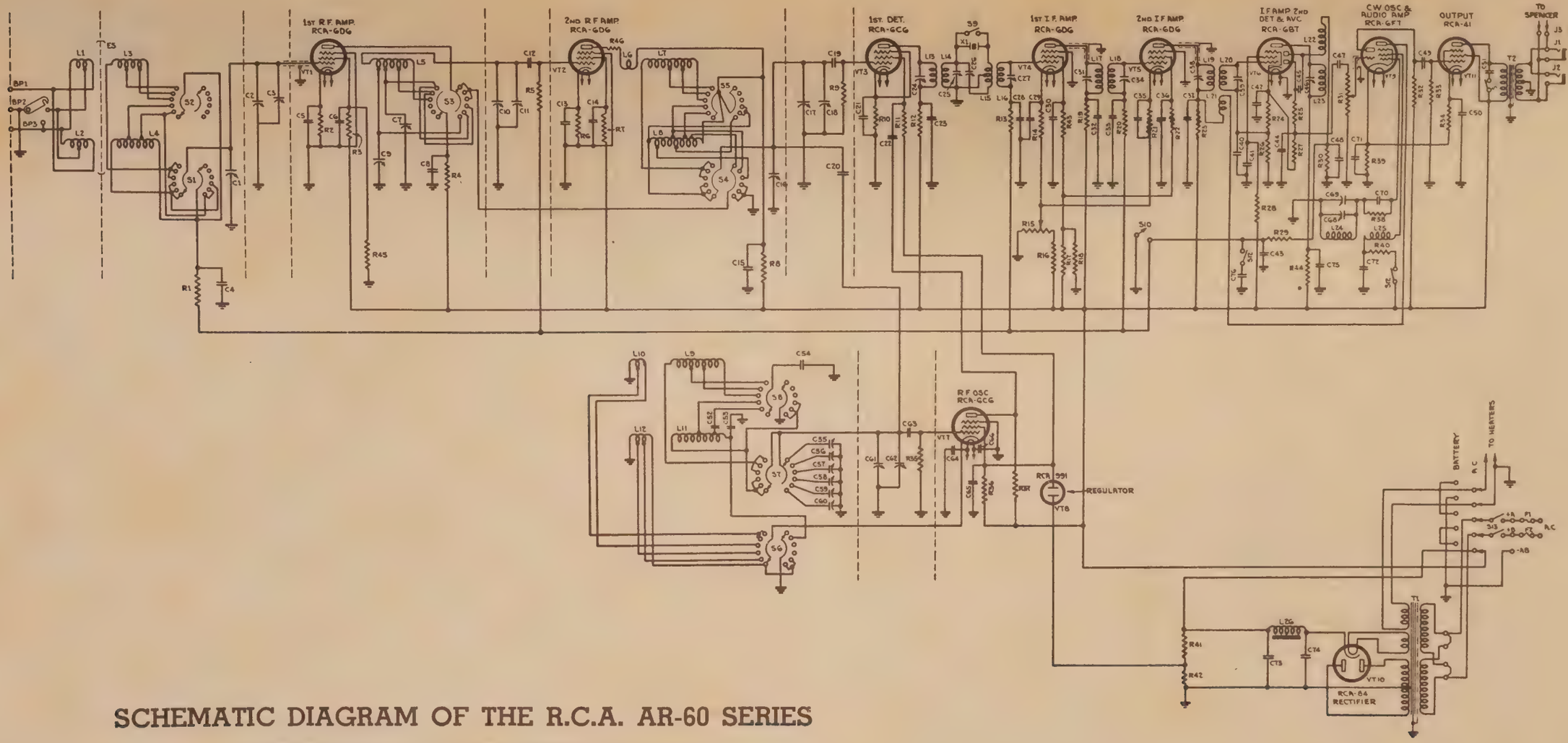


Figure 3

Above is shown in detail the construction of the "end splice." It makes a better-looking splice than an ordinary overlapping splice. Below it is shown construction of one of the two similar sides of the tower. No brains required for building, but keep wood butchers away. To show constructional detail better, the illustration is not drawn to scale.



SCHEMATIC DIAGRAM OF THE R.C.A. AR-60 SERIES COMMERCIAL SUPERHETERODYNES

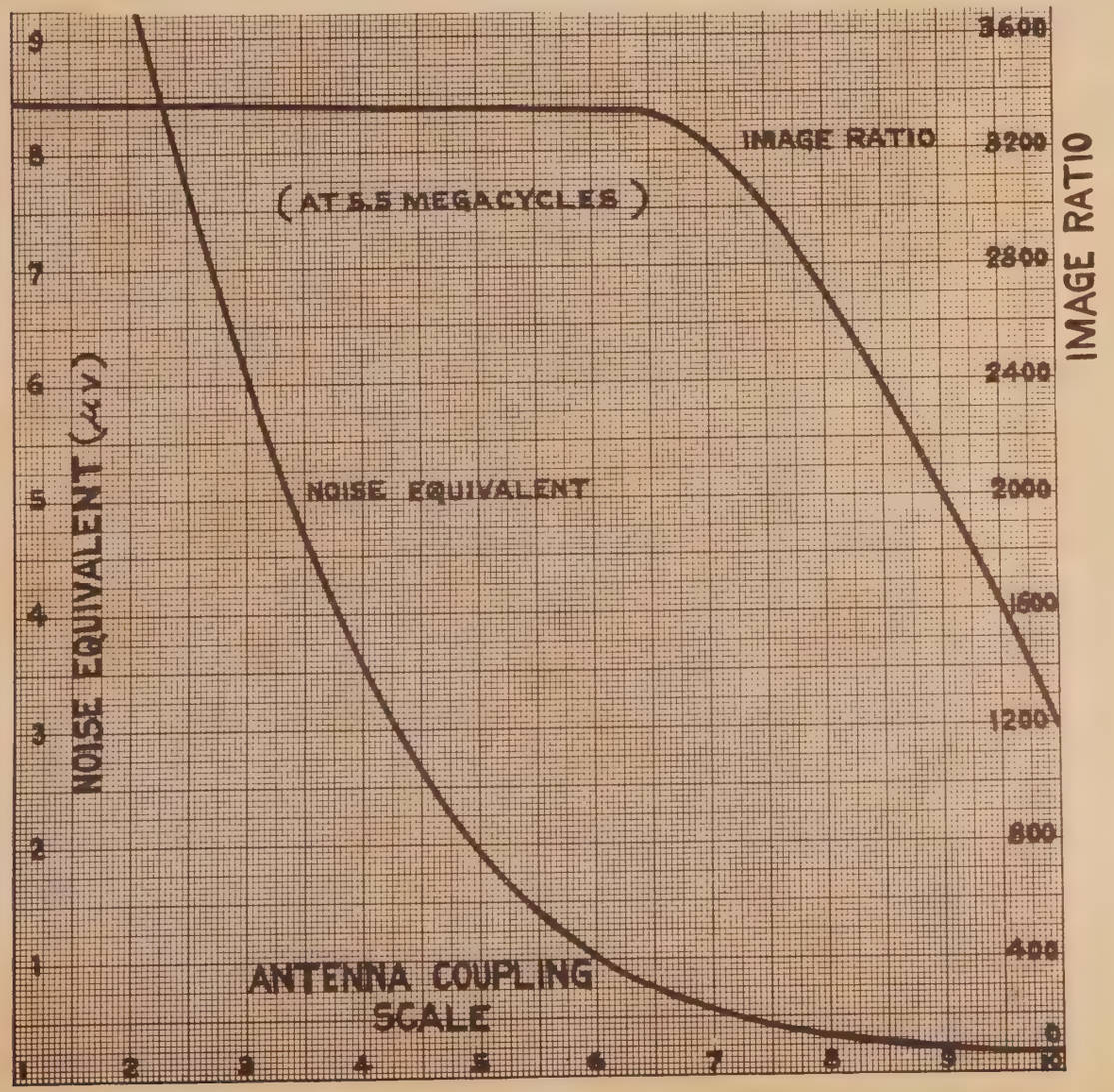


Figure 1

Image ratio versus noise for different degrees of antenna coupling in the AR-60.

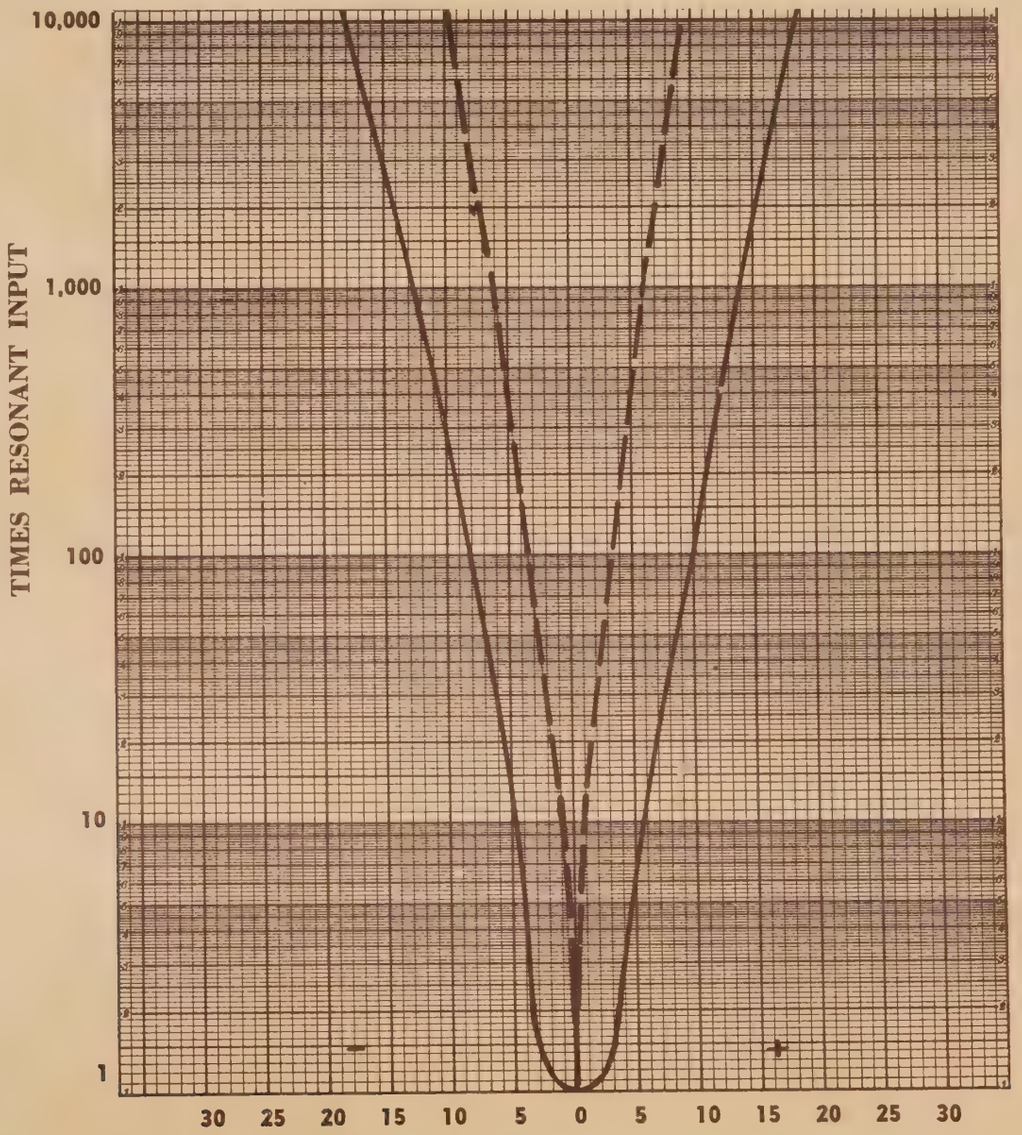
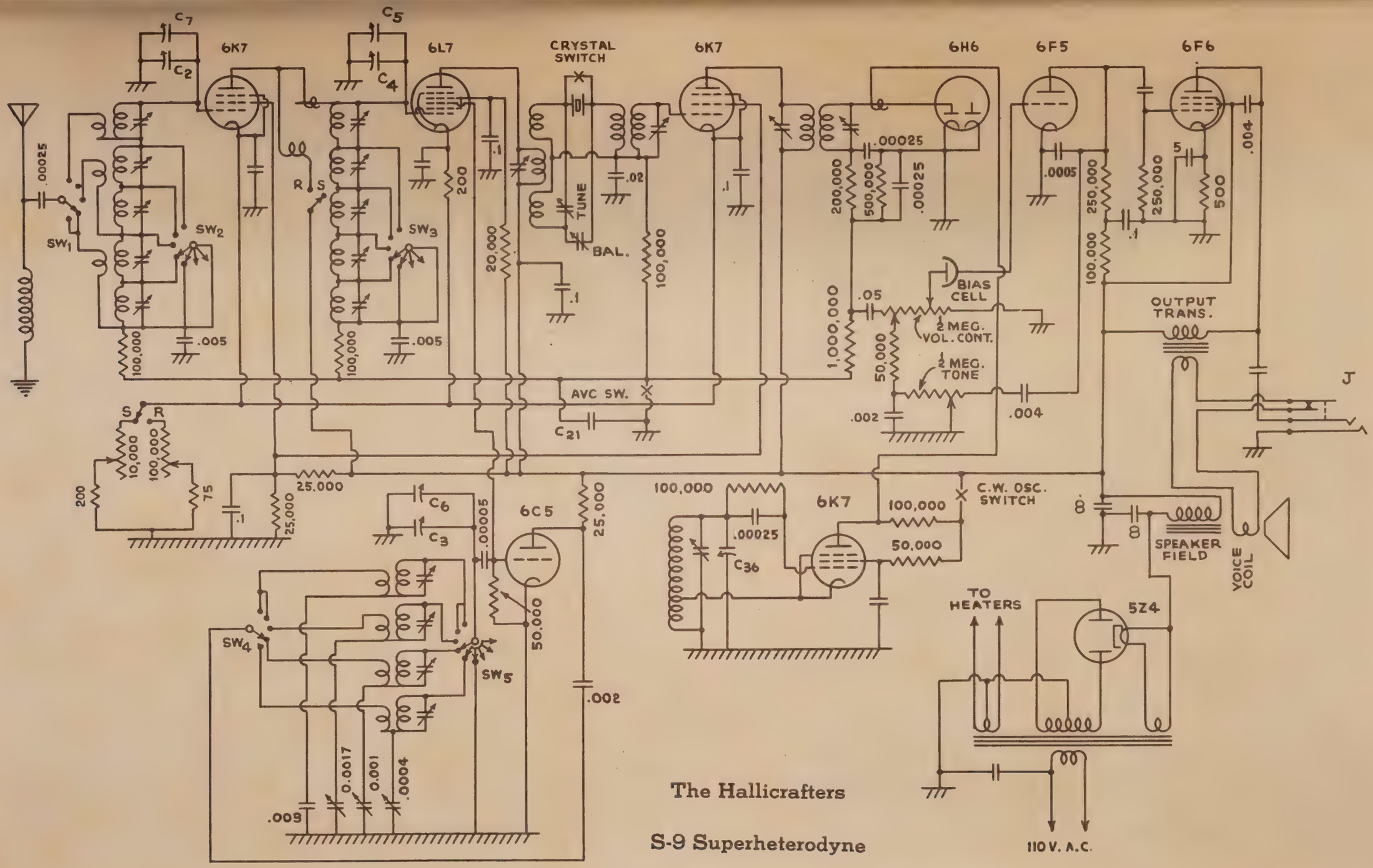


Figure 2

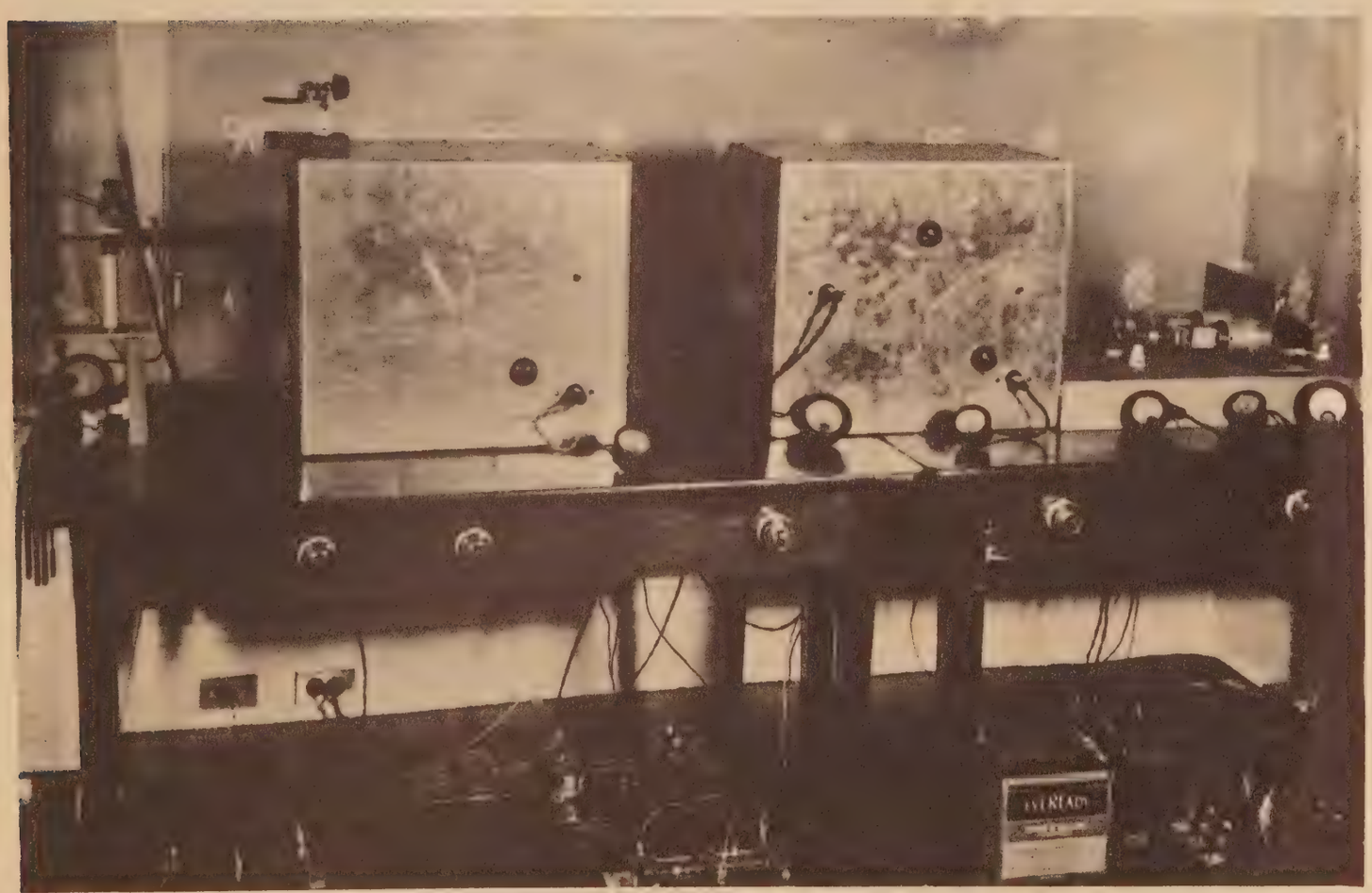
Selectivity with and without crystal filter, kilocycles off resonance.



The Hallicrafters

S-9 Superheterodyne

Frequency multipliers at W2AG for getting down to 7.5 meters



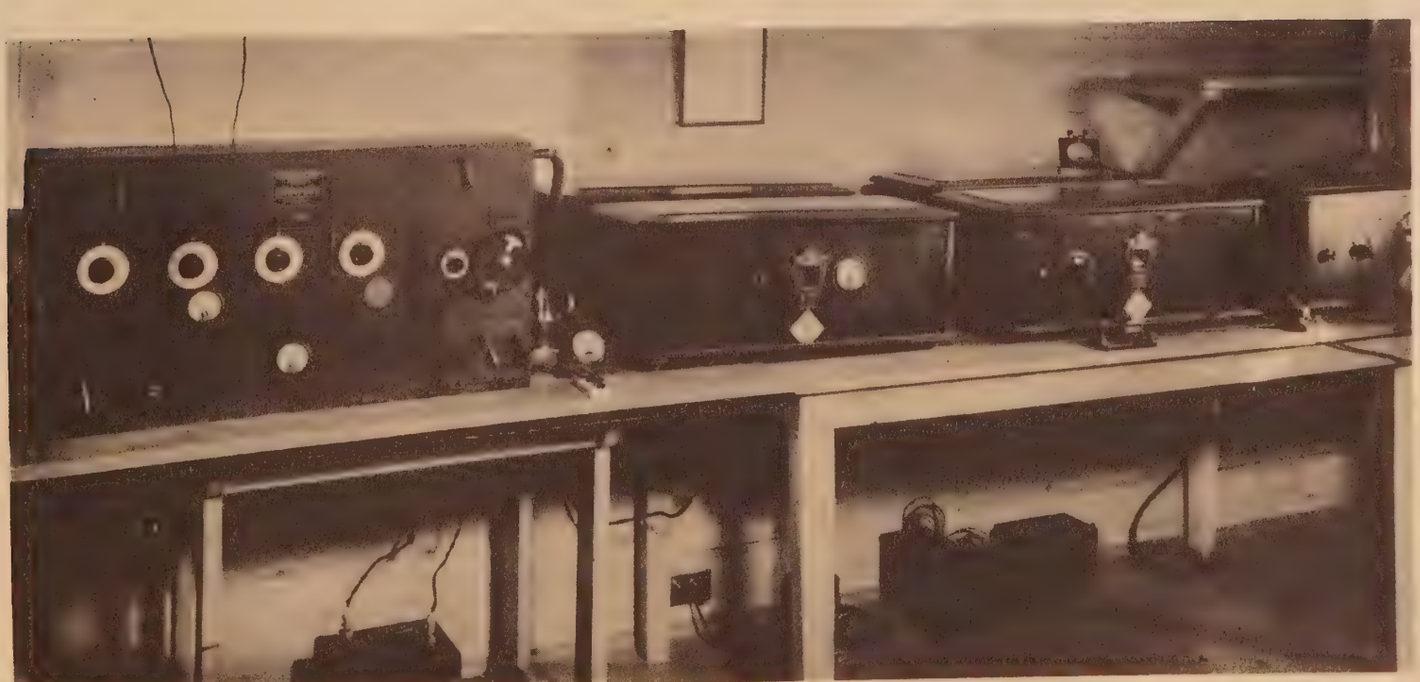
The power stages: Push-pull RK-20's to push pull 150-T triplers (enclosed) to push pull 150-T's on 2.5 meters (enclosed)

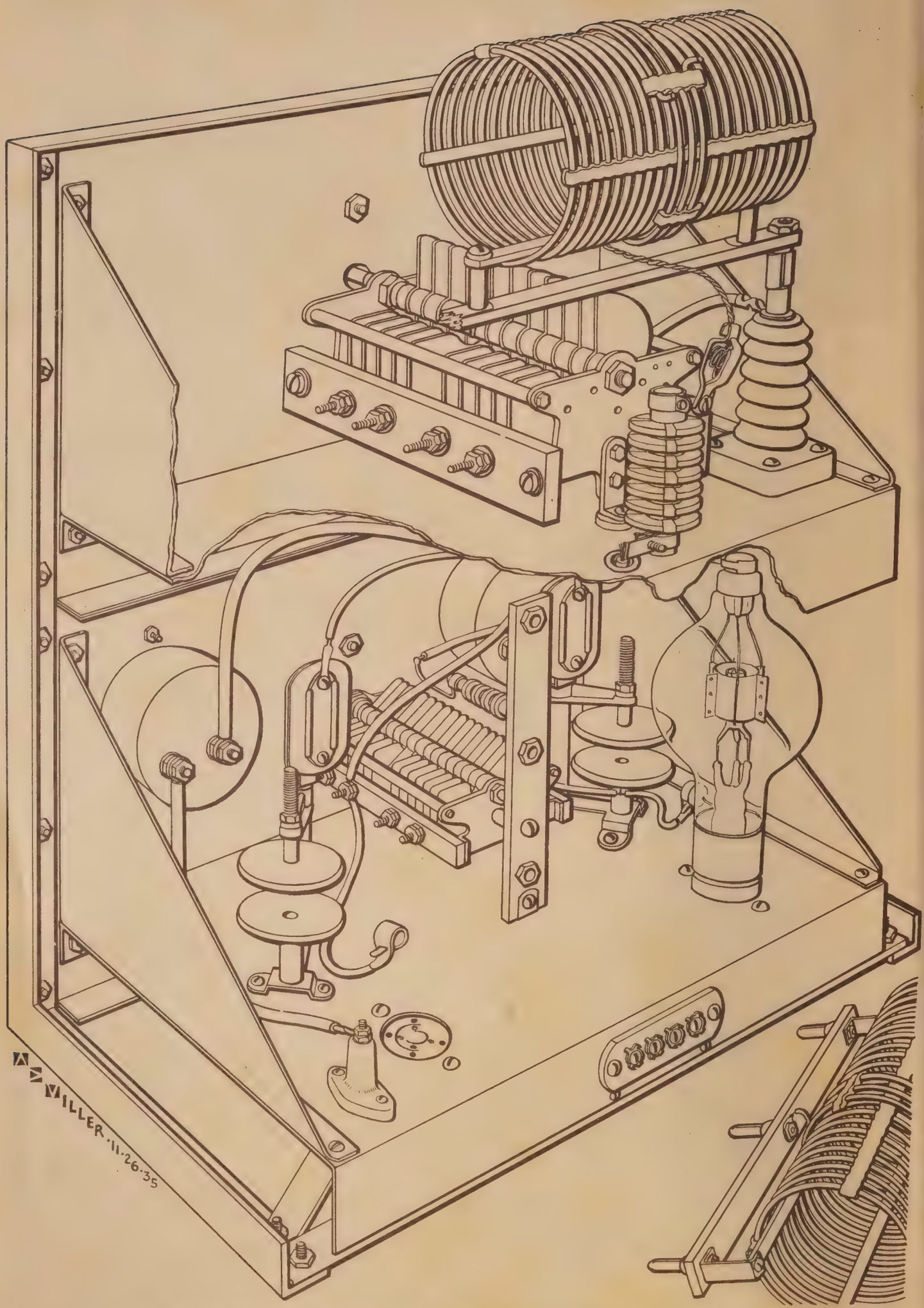
Above and to the left: 8 months improvement as shown by shrinking receiving antennas at Haddonfield.

Below: The Modulator at the Empire State Building.

Above: The Haddonfield Receiver

Above and below: The Westhampton Receiver





Cut-away view showing constructional detail of Dawley 500 Watt Amplifier

A 500 Watt Amplifier in Sunday Clothes

By Ray Dawley, W6DHG

Here is a high-power (400 to 600 watts output) amplifier stage to add to your present low-power rig. In a future issue will be shown a suitable exciter, built to match, for those who have no present equipment and have to build their transmitter from "scratch." This amplifier is a good example of the feasibility of building compact apparatus without sacrificing efficiency.

Very few rack-mounted final amplifiers are symmetrical enough to be free from bugs on ten meters, and thus such amplifiers usually suffer from high minimum plate current (unloaded) on the higher frequencies. The amplifier shown in the photos is truly all-band in that the minimum plate current dips to just as low a value on ten as it does on 80 meters. Particular pains were taken to keep the r.f. leads short and symmetrical, and it was found that this materially improved the operation of the amplifier. The circuit diagram is very conventional, except for the fact that the rotor of the plate tuning condenser is not grounded, but is allowed to float. On forty meters it was found that there was no difference in the operation of the amplifier whether the rotor was grounded or not, but due to the fact that the tube capacities can never be exactly balanced to ground, it was found desirable to let the stray tube and circuit capacity establish the ground point for ten and twenty meter operation.

The grid tank is link coupled from the preceding stage and this type of coupling proved very satisfactory.

Neutralizing

Due to the symmetry of the circuit, neutralization was perfect and the stage showed no signs of self-oscillation even with the bias lowered below cut-off and the excitation removed. However, it should be noted that the grid and plate choke should have different characteristics, as otherwise the two tubes sometimes act in parallel as a "TNT" oscillator with the grid and plate chokes acting as the tank circuits.

The neutralizing condensers are protected against d.c. flashover by the fixed 0.0005 μμfd. mica condensers in series with each condenser. This refinement is not absolutely essential but serves to protect the tubes and the r.f. chokes in the plate and grid leads.

The grid coils and plate coils are of the new wire-wound type that is becoming so popular for low loss circuits. The coils shown use fire-resistant ribs and the new chrome-oxide wire.

The rack is a standard product but can easily be copied by any sheet metal shop. An exciter is under development to be used with this final amplifier and will be described soon. At the present time it is still in the breadboard stage, but will ultimately be mounted in a similar rack. It may seem unusual to build the final amplifier first and then develop the exciter unit. However, this is the logical way to proceed as it is far more economical to design and build the final amplifier before, and not after, the exciter is built. The final amplifier is the key stage of any transmitter so that everything in a rig must work to get maximum efficiency and output from the final amplifier. Thus only after the final stage is built and operating with some form of breadboard exciter can the exact excitation requirements on all bands be accurately determined, and the exciter be designed.

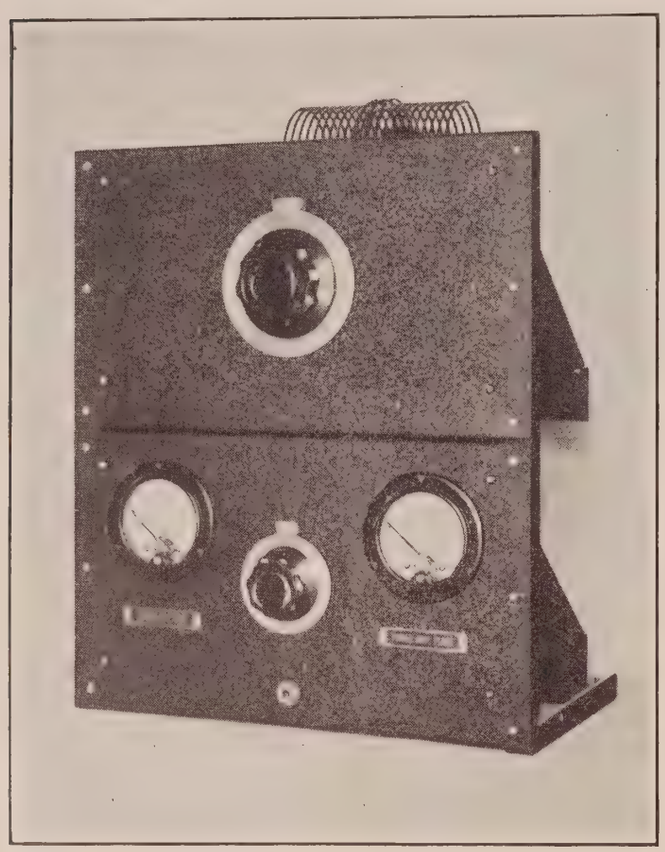
Excitation Requirements

The design of the r.f. exciter for this particular final amplifier will depend, to a great extent, on the d.c. plate voltage available for the final amplifier. This stage was primarily designed for 2000 volt operation, but has been tested all the way from 700 to 3000 volts in order to determine its power output and power gain at different frequencies. Of course the higher the plate voltage the higher the power gain and output, but in many cases amateurs will want to utilize their present power supplies so that a wide variety of plate voltages were tried out.

The first limitation on plate voltage is the plate tank condenser. (There is practically no limitation on the voltage that the tubes will stand. However, there is little point in going above 3000 volts.) The tank condenser shown will stand 2500 volts with the antenna uncoupled and 3000 volts with the antenna coupled. For plate modulation 2000 volts is just about the most that should be used with this tank condenser, particularly on the higher frequencies.

The average plate current rating for class C

use on the Eimac 50T was recently changed from 100 ma. to 125 ma. per tube. Thus the maximum allowable *rated* d.c. plate current for this amplifier is 250 ma. However, some months' experience with this tube indicates that 150 ma. per tube is perfectly satisfactory for *c.w. use,* due to the fact that the above rating



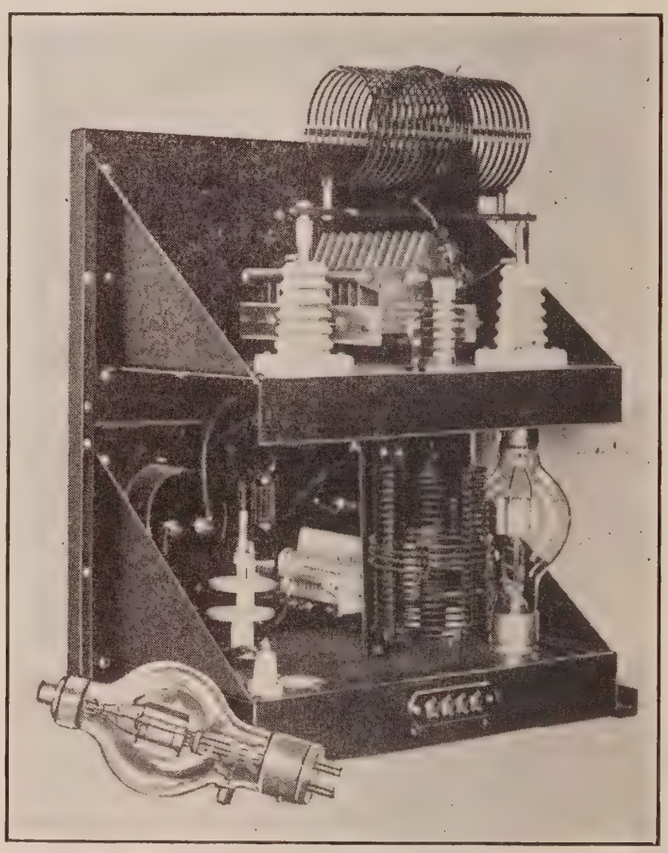
500 Watts in One Cubic Foot

is for plate modulation of a phone transmitter, and that the filament emission gets a rest in a c.w. transmitter when the key is up. Thus 300 ma. for the tubes is perfectly permissible for c.w. use in this transmitter, *provided* that the plate loss does not exceed 150 to 175 watts for the two tubes. With 60 ma. of grid current through two and a half times cut-off bias and 3000 volts plate voltage, no trouble was experienced in obtaining 85% plate efficiency and over 750 watts of power output with slightly less than 900 watts input. Getting this much power output requires careful adjustment of the antenna coupling and tank condensers and necessitates the use of fixed bias from batteries or a separate pack plus an overload relay in the high voltage supply in order to protect the tubes in case of failure of the crystal to start or due to an unexpected parasitic oscillation in the final amplifier.

For general c.w. use at 2000 volts plate voltage the following set of operating conditions will be about normal for this amplifier: Plate voltage, 2000 volts; d.c. plate current for both tubes, 300 ma.; indicating a d.c. plate input power of 600 watts.

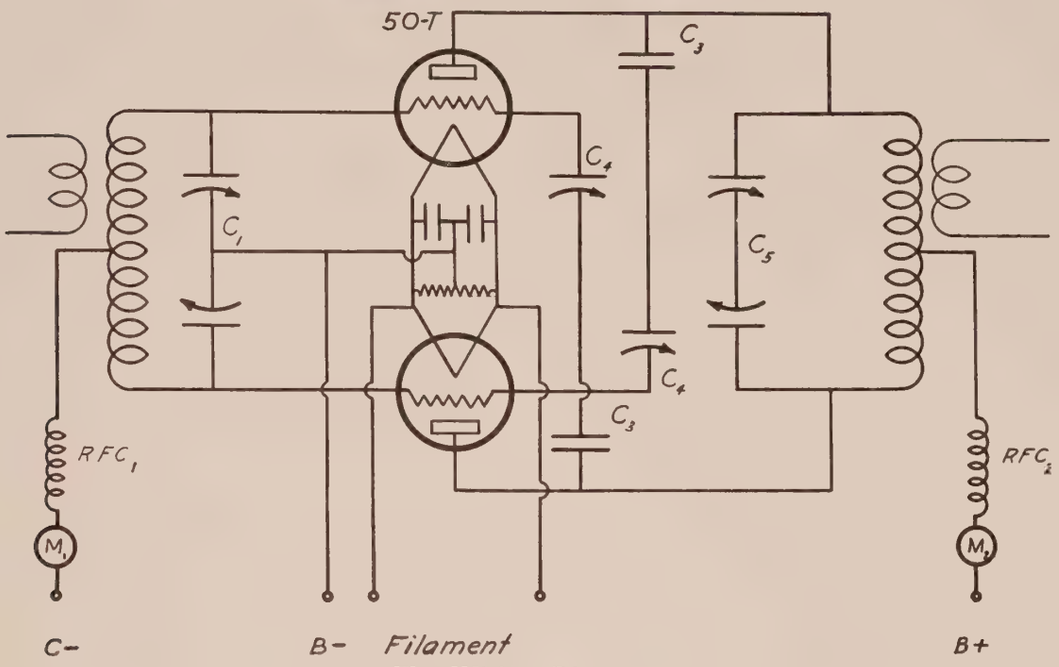
Optimum grid drive will be indicated by 45 to 50 ma. of d.c. grid current flowing through 350 volts of negative bias. About 25 watts of r.f. grid driving power must be applied to the grid circuit on 20 and 10 meters and about 20 watts on 40 and 80 meters to realize this optimum grid excitation. The amplifier will operate between 75% and 80% plate efficiency under these conditions, depending on the tank coils used and how little resistance there is in the tank circuit connections (plugs and jacks for the tank coil).

At 75% plate efficiency the power output will be 450 watts and at 80% plate efficiency the output will be 480 watts. It is possible to



Back view with one tube removed in order better to show constructional detail.

increase slightly the power output and plate efficiency by using more grid drive so that the d.c. grid current goes up to 60 ma. or so. However, this will cut the power gain through the stage down from about 22 to about 16, which begins to become uneconomical. After all, the whole point to an r.f. amplifier is to obtain power gain, and in order to realize the most watts per dollar it is necessary to compromise



The Wiring Diagram

C_1—70 μμfd. per section, 3000 volts.
C_3—500 μμfd., 5000 volt mica.
C_4—Neutralizing condensers, 5 μμfd., 6000 volts.
C_5—50 μμfd. per section, 6000 volt spacing.
RFC_1—100 ma. r.f. choke.
RFC_2—500 ma. r.f. choke.
M_1—0-100 ma. d.c.
M_2—0-500 ma. d.c.

between high plate efficiency and high power gain. Also, excessively high d.c. grid current is hard on a tube. It has been said that a given amount of d.c. grid current uses up as much filament emission as 50% more than that value of plate current. In other words, raising the d.c. grid current 10 ma. may be just as hard on the tube as raising the d.c. plate current 15 ma. This relationship is not strictly linear; a general rule cannot be deduced from it, but it is well to keep it in mind.

The best rule of thumb to follow in adjusting this amplifier and figuring its grid excitation requirements is to figure that at 75% plate efficiency the power gain will be at least 20. This figure is conservative and even holds at 10 meters. This is true when the bias voltage is somewhere between twice and two-and-a-half times cut-off. Cut-off bias can be calculated by dividing the d.c. plate voltage by 12, which is the μ of the 50-T. At lower values of bias the power gain through the stage will increase, but the plate efficiency (and thus the power output) will decrease.

If you intend to build this final amplifier and operate it from your present r.f. exciter and do not know the power output of your present exciter, the best method of adjustment is to use all the excitation you have and, starting with high negative bias on the 50-T stage, reduce the bias down toward cut-off until the d.c. grid current reaches 45 to 50 ma. The bias should not be lowered below cut-off, but remember that it is more desirable to run the tube at optimum d.c. grid current and low bias than at high bias and low grid current. The point is that the stage has more output and power gain running at 50 ma. of grid current and only class B bias (cut-off) than with 25 ma. of grid current flowing through twice cut-off bias, which represents approximately the same amount of grid driving power.

Antenna Coupling

No complicated antenna coupling network has been provided because such networks are usually unnecessary and sometimes even undesirable on the high frequencies. They often help to couple to a Marconi antenna on 160 meters, but other cheaper coupling methods give at least as good results on the higher frequencies. Probably the best low-cost antenna system is the twisted pair doublet using low loss cable (such as the "EO1") between the antenna and the final amplifier. The next best method is to link couple the final stage to a separate antenna tank in order to couple the feeder or feeders to the final amplifier. The feeders can be either zepp. (resonant) or of the one or two-wire non-resonant line type.

In order to get high plate efficiency it is essential to avoid reactive antenna coupling. It is well to avoid the conventional zepp. coupling

[*Continued on Page 101*]

28 Megacycle Activity

[Reports and other material referring to the 28 and 56 mc. bands should be sent to E. H. Conklin, W9FM, Assistant Editor of RADIO, 512 No. Main St., Wheaton, Illinois, who will correlate and assemble the data for publication. Reports should *reach him* by the 22d of each month.]

With the 10 meter band consistently open for any distance greater than 1000 or 1500 miles in October and November, two-way work with Africa, Europe and Asia almost ceases to be news. Rather than to mention outstanding QSO's this month, we are presenting a picture of midwestern conditions (average for U.S.A.) reviewing a few hours' work at W9FM (near Chicago).

On Sunday, November 10, we warmed up the filaments at 9:45 a.m. Central time to hear W6SN, probably a harmonic, and then a CQ from HB9J. We raised him for his first W9 contact, giving him R7 and getting a QSA5 R5 report. . . Following this, W7AMX was heard R9. . . a weak signal from W9BPU (120 miles). . . a harmonic from W6GAL . . . W9DRD (Kansas) calling F8CT . . . W8MWL . . . W9NY (90 miles) . . . X1AA talking Spanish with OA4J . . .W6GRX . . . VE1EP . . . W8IXS . . . W9AGT calling F8CT . . . W9HAQ (130 miles) . . . W6BAY phone . . . W7BPJ . . . W6BYU and W6CNX calling and working EA4AO, probably on 14 m.c. . . W6KIP . . . W4AJY (Alabama) . . . W4MR (North Carolina) . . . W6JNR . . . W6EWC . . . W9FLH (100 miles) . . . W7CHT . . . W6DOB working F8CT . . . W6DIO . . . W2BCR and W2DTB . . . W6CXW and W7AMX calling F8CT . . . VE5PT . . . W8CRA working F8OZ . . . W7BPJ telling W9BMM about working ZL1GX and J2IS on the 9th . . . W9ICO calling ZT6K . . . W6BIP . . . worked W6KJG . . . W4EF working EA4AV . . . EA4AV working W1IFS . . . W9MCD (200 miles), W9GYK and W9GHN (Wisconsin) calling VP5AC . . . W6GEI . . . VP5AC . . . W6EWC calling LU9AX . . . signed off at 12:30 p.m.

Starting earlier the next morning, at 7:20—W9NY . . . G6QB . . . X1CM calling VE4RO . . . W4AGP (Florida) . . . W4EF working G5FV . . . W9KFA (200 miles) calling F8VS. . . Worked F8CT who says he has no calls heard list because there is always someone calling him . . . W4CBY called by a D4 . . . OK1AW working W1ZB . . . F8VS calling W4CBY . . . W6MKL harmonic calling VS2AG . . . W1FJN . . . W6DFO . . . Worked ZU6P who tried phone—he still needs VK and J for W.A.C. . . . W6DIO . . . W4CBY calling G5FV . . . F8CT calling W9KFA . . . X1AM . . . W6KPR . . . W6BCO . . . W6EWC . . . at 10:00 a.m. worked F8KJ getting QSA5 R6 . . . W6GEI . . . W6GRX . . . Worked W6JN . . . Worked VE1EA for his first QSO on 28 m.c. . . Worked ZS1H getting QSA4 R5 with QRM from George Grammer, W1DF . . . W9FUR (80 miles) . . . in late afternoon, W6INN . . . W6FQY phone working W3FAR . . . W7EOF . . . W4AJY . . . W7AMX . . . W2BCR . . . W7CHT . . . W6KRB . . . W9GYK . . . at 4:00 p.m. VE5PT . . . Worked W6EWC . . . JAY harmonic . . . W6ZH phone R9 having a rag-chew with VK3YP . . . W6IHZ . . . VE4LK calling J2LK . . . W7AEM . . . W6KPR . . . VE5FU . . . W7AYQ phone . . . W6HE . . . W7FH . . . W6JO . . . W6DOB calling J2LO . . . W6KG . . . W7TS . . . TDC harmonic . . . W6IXJ . . . W7EPT . . . W6BAM calling ZL2KK . . . ZL2KK working W9ABE and W4HB . . . W6AAA phone . . . at 5:45 p.m. worked VK3YP who said "please QRK? then will give you some dope for *R/9*!" . . . VE5FO . . . VE5FC.

W6DOB worked all continents on 28 megacycles on November 15th . . . quite an accomplishment from the 6th district. Then W6FQY made the boys all take notice by working all continents on *phone.*

VK3YP, W8CRA, and W6DOB held 3-way solid QSO for over one hour on October 29th and on November 14th. That's not bad for any frequency—let alone 10 meters!

Recently W6KJG tried both a half wave vertical and a two-wave horizontal antenna when working W9LS and W9FM. Both reported the horizontal about 2 "R's" better. This is very interesting, but should not be taken as conclusive inasmuch as the opposite results may be reported at a distance of perhaps 4000 miles, due to the angle of radiation. We know that W9NY gets out very well on his pair of 801's using a vertical half-wave, and doubt if he could improve his reports if he were to replace the vertical with a long horizontal antenna.

Lately, several stations have reported consistent signals from 100 miles and more away when a vertical transmitting antenna is used, regardless of the skip distance at the time. This suggests 100 to 200 mile duplex communication with ordinary equipment on 28 and 56 mc.

In a fine 10 meter QSO on November 11, VK3YP gave us this picture of conditions in the southern hemisphere:

"28 mc. has been f.b. here for the last two months and is steadily getting better. No VK yet is W.A.C. but several have five continents. South America is the stumbling block. We work the U.S.A. from 2000 to 0200 g.m.t., Europe 0700 to 1100, Africa around 0800, and Asia all day. I worked 75 U.S.A. and 48 Europeans last month." Comparing this with conditions in the U.S.A., notice that north-south can take place all day, east-west work is more difficult, while the combination paths are reasonably sat-

isfactory; this agrees with the data in the article entitled, "Propagation of Short Waves" in *R/9* for October, 1935.

Those who are skeptical about communication possibilities in the 10 meter band are referred to the calls heard list (page 76) of G2HG received November 17 via this band, without repeats and through normal auto ignition QRM.

In working on the high hiss level in a superheterodyne on the high frequency bands, one of the gang increased the receiver plate voltage to a full 250. It wasn't five minutes before he heard his first European on "10" and worked him. What a difference! When the same stunt was tested on the 20 meter band, it was found that early-morning dx could be heard about an hour earlier than before, due to the better signal-to-hiss ratio. We do not claim this is a cure-all to the problem, but it is worth considering.

The following is a list of foreign 10 meter stations and their most-used frequencies. It should be an aid in "stalking" elusive countries or continents not commonly heard in a certain location. The list was compiled through the combined efforts of W3DLB, W9NY, and W9FM. The frequences are not exact, but are close enough for all practical purposes, especially since but few amateurs can accurately measure frequencies closer than about 25 kc. at 28 megacycles. All stations listed are quite active and most are heard consistently under good conditions.

28.00	x1ay, hb9j.
28.03	vk3bd, zl3aj.
28.04	zu6p, ok1aa.
28.05	vk3yp, g2nh, lu3dx, d4ltn.
28.06	lu1ep, vk2lz, g5wp, lu9ax, g6nf, zl1gx.
28.07	lu9bv, d4kpj.
28.09	f8wk, g2hg, g6lk, d4gwf, d4arr, vk5hg.
28.1	g5by, g5la, g6zv, f8vs, zs1h, g5fv, f8oz, lu3dd, x1aa, pa0az, f8wk, g2pl, d4ort, g6gs, zu1c.
28.2	g6qb, sm6wl, on4au, vk4gk, pa0qq, ym4aa, j2hj, ea4av, vk4bb, g2yl.
28.3	g2yl, vk4ap, vk2hz, vk3bq, g6wy, oa4j, x1cz, d4auu, g6nf, on4ac, on4jb, ok1aa, f8pu, f8rj, k8kj.
28.4	j2jk, g6cl, fa8cr, fa8ih, vk4bb, f8rs, j2hj, vk4ei, j3fj.
28.5	ok1aw, f8ef, zl2kk.
28.6	ea4ao, ei5f, ea4av, ve1dr, zl1gx, zl2gq, vk4ei, f8ct, vp5ac, j2lk, vp5pz, j2dv, x1cm.
28.7	g2mv, lu3dh, cx1cg, x2c, j2lk, x1am, vk7kv.
28.8	su1sg, k6ksi.
28.9	x1cm.

As we go to press, WAC is being made right and left on 10 meters, several being made on phone. And to think that three months ago many hams were pessimistically prophesying that "It can't last; the hot period must be about over. By the time I got my rig cranked up on 10, the band would be dead. Yeh, I think I'll stay on 20." These are the boys that are now "chawing" their nails down to the quick, and asking "How many turns 3 inches in diameter will hit 10 with about 15 micromikes?"

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WESTERN ELECTRIC 307-A

The Western Electric 307-A r.f. pentode is a tube of the general class represented by the RCA-802, the RK-23-25 and the like. The tube has the familiar dome-top bulb but is less elaborate internally than the 802, does not have the 802's "internal shield" and lead therefrom. The plate is corrugated. From here on the story is most easily told by the usual scheme of setting down data, thus:

	Western Electric 307A	R.C.A. 802
Filament	5.5 watts at 5.5 volts	5.8 watts at 6.3 volts
Plate, maximum dissipation	15 watts at 500 volts	10 watts at 500 volts
Input capacitance (grid to rest)	15 μμfds.	12 μμfds.
Output capacitance (plate to rest)	12 μμfds.	8.5 μμfds.
Feedback capacitance (plate-grid)	0.5 μμfds.	0.15 μμfds.
Base	5-pin std.	Med. 7 pin.
Top cap connection	Plate	Plate

The 2-pin discrepancy between the bases of the tubes is accounted for by the 802's indirectly heated cathode as against the 307-A's direct emission, and by the 802's internal shield already mentioned.

Continuing with the comparison, and turning to practical operation we have:

	Class C Telegraphy with key locked		Class C Telephony with suppressor modulation	
	307A	802	307A	802
Plate volts	500	500	500	500
Plate Ma.	52	45	40	22
Screen volts	250	250(200)	200	200
Screen Ma.	18	12 (22)	21	28
Suppressor grid volts	0	40 (0)	-50	-45
Suppressor peak audio volts			50	65
Input grid volts	-35	-100	-35	-90
R.F. peak grid volts	50	135	50	125
Mutual conductance			3600	2250
Carrier watts Output	17	16(14)	6	5.5

The above is from published data only. None of these tubes (307-A) has as yet been made available to RADIO.

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Be sure to read the contest announcement on page 80.

The Armstrong System of Modulation

By Robert S. Kruse

In recent months there has been much ado about the new Armstrong system of modulation; considerable premature speculation has appeared in various periodicals. The exact details have, for obvious reasons, been shrouded in secrecy. We are pleased to present an authentic account of the fundamentals of the new system, from information obtained in a special interview with Major E. H. Armstrong.

Once more a "worthless" thing has produced new and useful results. The familiar Biblical words, "The stone which the builders rejected, the same is become the head of the corner," apply with startling aptness, for some of the most prominent men in radio have condemned frequency modulation for its faults, and accused it of lacking any compensating advantages whatsoever. In this they were right, for they had in mind the *conventional sort* of frequency modulation which is no more than a "wabbling" back and forth of the carrier frequency, the wabbling being in accord with the variation of speech or music. This is the sort of modulation which appears as an uninvited by-product in amplitude-modulated self-oscillators such as are found in most of the current "transceivers" and similar simple 5 meter equipment.

Additional photos of the Armstrong equipment will be found in the offset section of the magazine.

The Armstrong Frequency-modulation System

The Inventor: Major Edwin H. Armstrong, Professor of Electrical Engineering, Columbia University.

The Transmitters: 50 watt and 2 kilowatt at the Empire State Building in New York working at 41 megacycles (*not now in operation*). 100 watt at W2AG, C. R. Runyon, Yonkers, N.Y., operating at 120 megacycles.

The Receivers: At Columbia University, at Yonkers (W2AG), at Haddonfield, N.J. (Harry Sadenwater), at Easthampton, L.I. (George Burkhardt).

The Time: For almost 10 years, originally at the Marcellus Hartley Research Laboratory.

Some Comparisons: The 50 watt Empire State set with Armstrong modulation out-transmitted the 2 kilowatt conventional set at the same place by far.

During local lightning at Haddonfield (85 miles) the 2 kilowatt Armstrong transmitter at Empire State was barely interfered with. 50 kilowatt WEAF, WABC and local 50 kw. WCAU were hopeless.

W2AG to downtown New York about equal to 50 kw. WABC at same distance with clearer going.

Special Test: Multiplex used repeatedly, on one occasion to Haddonfield with N.B.C. program, two telegraph channels, a facsimile picture channel, and a synchronizing channel for the latter.

Before attempting to show that tht Armstrong method is not mere "wobbulation," let us cast back to the meaning of ordinary amplitude modulation, at present well-nigh universally used in radiophone transmitters making any pretense at good performance. In its commonest form this consists, as you know, of a "class C" triode which has 4 inputs:

1—The filament current, which is used for heating purposes only.
2—The d.c. plate input, which is unvarying and produces no sound in the receiver.
3—The radio-frequency grid-input, which is likewise unvarying and produces no sound at the receiver.
4—The a.c. plate input, which is recovered at the detector of the receiver.

All the solicitude expended upon our radiophone equipment centers around the desire to deliver this no. 4 a.c. undamaged to a detector, so that it may proceed in its proper form to a loudspeaker and there be re-converted to sound just like that which was fed into the microphone and there generated the a.c.—or, if you please, the audio-frequency a.c. Quite justifiably there has been very great engineering and manufacturing expenditure to assure that this process shall be unmolested by variations in those inputs we have called 1, 2 and 3. Crystal control, re-design of generators and rectifiers, filter research, improved tubes, study of audio and r.f. amplifiers, and many another matter has contributed. At the receiver also, intense effort has been put into the job of avoiding every bad influence upon the safe conduct of the precious audio a.c.

But Out in Space

But, alas, we cannot tie the transmitter to the receiver with a shielded wire. We must use that invisible, churning, and quivering electronic web we call "ether"—and in this ether many things interfere with our fine plans for the safe-conduct of the signal. Like a spider-

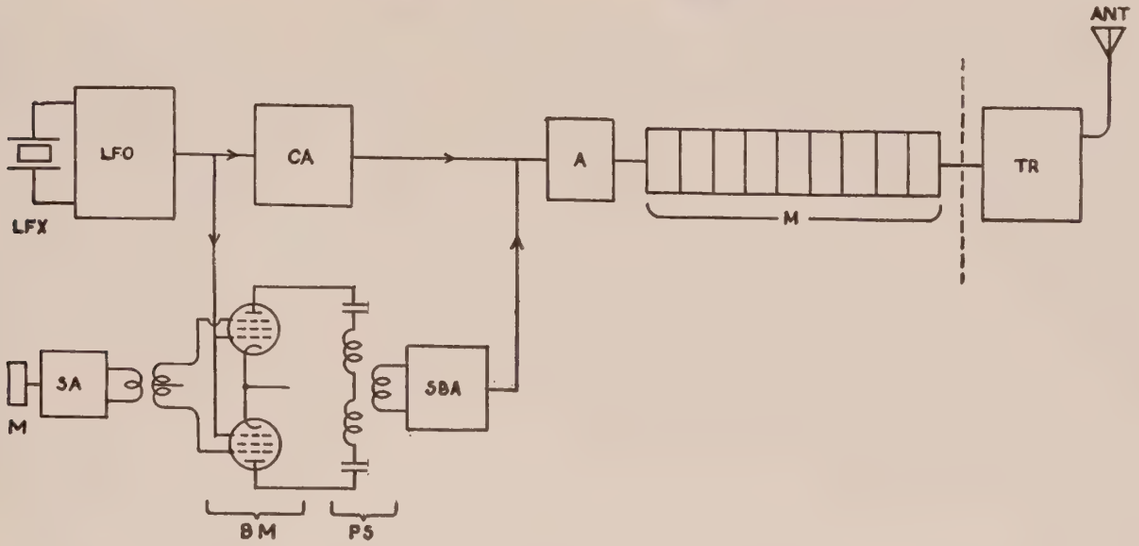


Figure 1
The conventional transmitter proper (TR), with its tuned circuits broadened, is retained as a power amplifier. The crystal oscillator is replaced by the equipment to the left of the dashed line.

LFX & LFO—Low frequency crystal and oscillator.
CA—Carrier amplifier.
BM—Balanced modulator with all needless detail omitted.
PS—Phase-shifting transformer.
SBA—Sideband amplifier.
A—Amplifier in which carrier and sidebands are recombined.
M—Multiplier of phase and frequency.
SA—Speech amplifier.

web agitated by the impact of raindrops it twitches to electrical impacts from lightning and from a million lesser electrical effects, natural and man-made. Thus we hear "static". Its upper levels roll and tumble under the influence of the sun and other things quite beyond our control, and unfortunately radio signals as usually sent do rise to those upper levels and come down once more to arrive at the receiving point more or less altered by their journey and no longer in good agreement with the other portion of the wave, which has arrived by running on the ground. Thus a "sky wave" interferes with a "ground wave" and we hear fading of the signal-loudness.

Still another effect of somewhat the same sort gives us "selective fading" in which the damage is not so much to the signal strength as to the goodness of the sound-reproduction, or "quality."

What To Do About It

In facing these static and fading problems radio men feel like that airman who was ordered by the field's radio station to stay away and not make a landing, but retorted:

"Take it up with God; the motor's conked."

There just hasn't seemed to be any great help, despite the most positive orders from broadcast listeners, commercial operators, and users of the radio links in our telephone system. Of course there are partial cures. Greater receiver sensitivity and automatic volume control make some fading signals useful, at the cost of increased amplifier noise and greater noise-pickup from outside during the fade-downs. Special antennas help somewhat. Stronger transmitters help by the brute-force process of overpowering weak interference, and forcibly shoving more signal out along the earth, with some chance that the sky-wave interference does not grow equally strong. This high-power method is so very costly as to be staggering.

The core of all the difficulty appears to lie in the disposition of the receiver. *For years it has been painstakingly developed to respond in precise proportion to any audio-frequency voltage-variation at its input terminals.* If the carrier-amplitude changes at an audio rate, the loudspeaker says so at once, reproducing the variation as to pitch and amplitude. It is no matter to the receiver whether the carrier-amplitude change was caused intentionally or accidentally; as long as it is an audio-frequency amplitude change one hears of it. Therefore no discrimination exists between modulation at the transmitter and modulation in the ether, though one is caused by sounds before the microphone and the other by wave-effects in space. Static and other large voltages are able to upset this voltage-conscious device thoroughly, even though briefly.

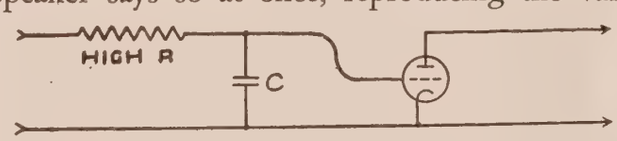
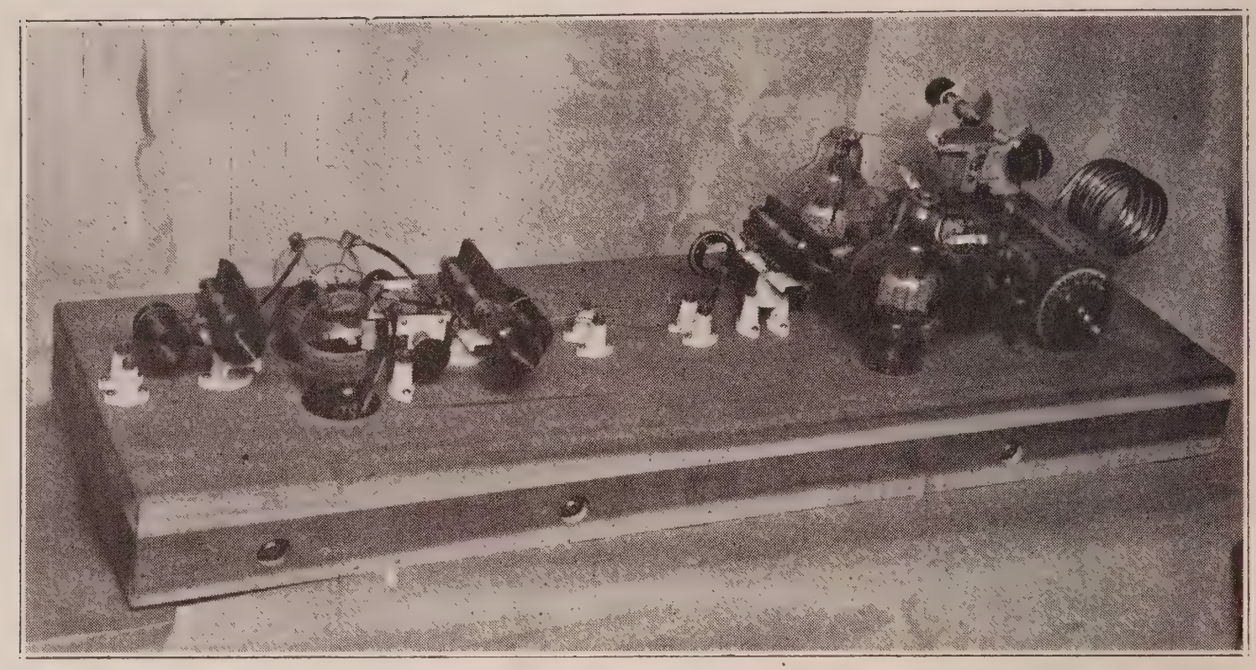


Figure 2
Principle of the audio correction net. The total drop is approximately constant because of the high resistance, while the drop across the condenser is inversely proportional to frequency, because the capacity reactance decreases as the frequency rises.



The power amplifier used at the Empire State Building to compare a 50 watt Armstrong signal with a 2000 watt conventional signal. The 50 watt Armstrong signal won by a wide margin. Observe the "true amateur" construction and the familiar link-coupled 800 and 852 tubes.

If, then, the core of the difficulty is in a receiving device which depends on audio-frequency variations in a steady r.f. voltage, the possibility exists that a cure may be effected by some system such as:

A—A receiver intentionally made very obtuse to changes in the carrier-amplitude at any audio rate, or at least not primarily dependent on such changes.

B—A transmitter in which amplitude-modulation has been replaced by modulation of frequency or phase.

C—The use of a transmission wavelength (the word is used for a purpose) for which static and fading are known to be moderate.

D—Some manner of response-limiter.

E—Some means of avoiding much effect at the loudspeaker from another disturbance not mentioned here previously, that of disturbing voltage arising in the tubes of the receiver.

How all of these features appear in the Armstrong system, and what their effect has been in tests, is to be the rest of this story.

Phase Modulation

If the frequency of an a.c. generator is increased by one cycle per second, then in comparison with the original frequency, we may say that the machine is "gaining one cycle per second" or that its "phase is advancing 360 electrical degrees per second." The two expressions in quotations are interchangeable, as one cycle is identical with 360 electrical degrees. This is merely to point out that a frequency change is a phase-shift. A frequency-increase is a forward phase-shift; a frequency decrease is a backward shift of phase.

Thus if we begin with a crystal-controlled oscillator and apply phase-shifts to its output we are frequency-modulating it—that is, waving the frequency back and forth in accordance with the voice. This has been attempted in the past by causing the audio amplifier to flutter one plate of the crystal holder. It is the writer's recollection that a very small frequency range was possible.

In the Armstrong system it is desired to waver the frequency over a very wide range, say 60 kc. each side of the "resting" position (more in some cases). To do this at the crystal holder is pretty clearly out of the immediate probabilities—though the word "impossible" is not being much used just now. This problem is solved by applying the phase-modulation to the output of a low-frequency crystal-controlled oscillator *after* which the modulated output is put through numerous receiving tubes working as frequency multipliers, with buffers and filters at intervals to side-track unwanted frequencies generated during the process. The original phase modulation, even for the loudest sounds, is kept down to 30 electrical degrees (1/12 of a cycle). This seems a hopelessly small modulation but Major Armstrong states that the frequency-multiplier, without introducing any serious distortion, is in its present form able to increase the frequency several hundred to sev-

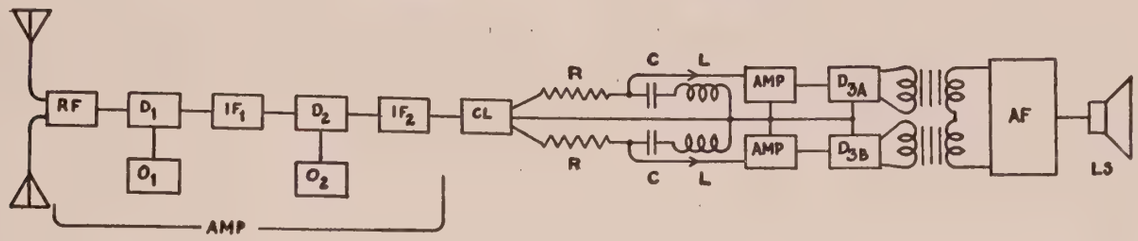


Figure 3
The Armstrong Receiver

AMP—High-gain amplifier with conversions from signal frequency to about 6 mc., then to conventional i.f., say 800 kc.
CL—Current Limiter.
R,C,L—Conversion circuits for detectors D_{3A} and D_{3B} respectively.
AF—Audio amplifier.
LS—Loudspeaker.

eral thousand times and at the same time to multiply so greatly the modulation-phase as to raise the original 1/12 cycle change to a frequency swing of as much as 75,000 cycles to either side of the "resting" frequency. This appears to involve phase-multiplications of about a million, perhaps corresponding to the square of the frequency muliplicaion.

The Machinery

This varying frequency, still at a very modest power level indeed, is now supplied to the transmitter at the place where it is usually fed from the crystal tube: that is, at a point where a watt or two of r.f. suffices to drive the following stages. Beyond that point there is no further need of modulation, but the tuned circuits must be broadened to pass the very wide frequency-swing-band. This is done by resistance-damping and other familiar means.

However, the method of originally creating the 30 degree phase modulation of the low-frequency has not been explained; we must retrace. The scheme is to feed from the crystal tube two channels. In one of them lies a straightforward amplifier stage, so that we may have a little more carrier and also some "buffer" action. In the other channel lies a "balanced modulator." This well-known device is a pair of tubes whose grids are fed in parallel (with r.f.) but whose plate coils are arranged to "buck" so that there is no r.f. output at all when "resting." Now if one grid (or screen) is made more positive while the same part of the other tube is made more negative, the balance is upset and some power escapes to the common output coil, which is coupled to both plates. This output is r.f., but not at the carrier frequency. It is sideband power; there is no carrier. Thus a balanced modulator is a device for generating sidebands without a carrier. The audio modulating voltage, as suggested, could be applied to a grid in each tube. This has usually been done at the input grid of triodes, which accordingly must be in parallel at r.f. and in push-pull at a.f. To avoid the resulting choke-coil and stopping-condenser combination, one may instead supply the audio to the two suppressor grids, letting the r.f. have the input grids for itself.

The balanced modulator is followed by a sideband amplifier, which is just an ordinary r.f. pentode like the carrier amplifier in the other channel. The outputs of the carrier amplifier and the sideband amplifier are resistance coupled into another receiving pentode and thence to the multiplier-and-occasional-buffer-string which in the end feeds the front end of the original transmitter.

Several things are still wrong with this picture. The balanced modulator would appear to be producing ordinary amplitude modulation, which isn't wanted. Also it would seem as if the phase modulation, if produced, must be proportional to audio frequency—which also is not wanted. (The phase modulation, and its descendant the frequency-departure of the final high-frequency carrier, are to be controlled by sound loudness only.) Two more devices are introduced to change this situation. One is a simple distortion device in the audio amplifier feeding the balanced modulator, such that the output of the amplifier falls off as the frequency rises, thus compensating for the objectionable effect mentioned in this connection. The other device produces a phase-shift of 90 degrees in the balanced modulator's output before it is re-combined with the carrier. This is done by the output transformer of the balanced modulator.

Why So Wide a Band

Band widths of 150,000 cycles sound rather tremendous when we are accustomed to a broadcasting system with 10,000 cycle channels. The use of so wide a band automatically locates the system in the ultra-high frequency region, which still offers that much available space. But at the moment we are inclined to think of ultra-high frequency transmission as very

limited in range—perhaps not with complete justification. To such objections the workers with the system reply that the "primary coverage" of a 50 kilowatt broadcasting station is surprisingly small, and that in numerous tests a 2 kilowatt transmitter Armstrong-modulated has at distances of 75 miles or so delivered consistently-better signals than 50 kilowatt amplitude-modulated transmitters using the same program material. This argument is of course based on the idea that broadcasting is interested in city-area coverage; it does not include the other half of the people of the United States who live in opener spaces and get along very well with 550 to 1500 kc. broadcast signals outside the primary coverage territory. However, half the population is 60,000,000 people, so an improvement giving staticless and fadeless reception to the city areas is worth a very great deal. Obviously reception at a great many places in a city must be attempted to learn just how fully this hope may be realized.

This justifies the use of the ultra-high frequencies if they are the only means of using the Armstrong system, but again one asks, "Is so broad a band actually necessary?" This brings us to noise-pickup at the receiver.

Noise Reduction

The receiver must accept all frequencies across which we propose to wave the transmitter's frequency. At first sight this looks to be equivalent to accepting much more noise than in an ordinary receiver, and so it would be if the receiver were "voltage conscious" to the extent of the ordinary receiver. Even so the noise would not be 15 times as great as for the ordinary receiver, though that figure might be suggested by the relative pass-band widths. Once the pass-band has become perhaps 20 kc. wide there is no great increase from there on, as additional width does not place more noise within audio range of the carrier, where it can beat with the carrier to produce audio. Though the carrier be wavering in frequency, it cannot at any instant be within audio-beat range of more noise. Thus it is justifiable to widen the band further if there be any advantage gained. This advantage is then to be shown.

The Receiver

The receiver is a "super-superheterodyne," using two different intermediate amplifiers and providing a very large gain before detection. After the 2d intermediate amplifier there is a current limiter, which may for example be a 58 tube with 1½ volt bias, and 45 volts on screen and plate. This is followed by a "conversion circuit," a pair of balanced detectors and an audio amplifier.

The signal entering the receiver is first passed through an "acorn" r.f. amplifier, then to an acorn translator or "first detector" where it is converted to a (resting carrier) frequency of about 6 megacycles, amplified through several stages, then passed through a second translator (2d detector) and converted to a (resting carrier) frequency of about 800 kc. or some other conventional i.f., and then to the current limiter tube. Up to this point nothing but an unusually great superheterodyne amplification has taken place. At the current limiter something else does take place. The current limiter "re-

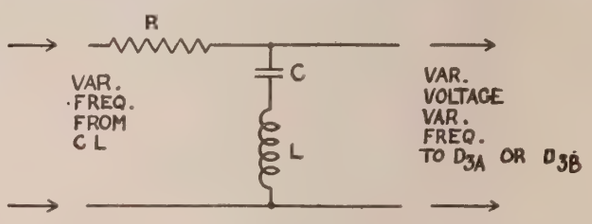


Figure 4
Principle of the conversion circuit. If R were removed the L-C combination would be resonant. Each of the balanced detectors has such a circuit, set on opposite edges of the frequency-swing band.

moves amplitude variations above a certain level"; it "suppresses the noise components which are at 0 or 180 degrees (phase) to the carrier, but has no effect on those which are at 90 degrees. These (components at 90 degrees) are not heard because they constitute phase modulation only." (Quotations from Major Armstrong during interview.) Each noise component in going through the current limiter creates an image of itself on the other side of the carrier and in the subsequent circuits is able to balance itself out, as are noises originating in the amplifier stages ahead of the current-limiter. It is necessary that the received carrier be quite strong when it arrives at the current limiter as it is the backbone of this process of maintaining a quiet zone about itself. This both permits and demands high amplification prior to the current limiter.

From the current limiter we go to the "conversion circuit," and at last arrive at a reason for the very broad band. To this conversion circuit is fed, by the current limiter tube, an input of varying frequency, and from it there must come out something containing as one component a varying implitude, so that the detector shall be able to produce an a.c. output to feed the audio amplifier and thence to the loudspeaker. The conversion circuit consists

of a high resistance, a condenser, and a coil, all in series. The resistor is not interested in frequency changes, and the voltage-drop across it is large and nearly constant as long as the carrier is running. However the L-C combination in series with the resistor has a reactance curve, its reactance going to nearly nothing at one point and rising on both sides in the familiar manner of such circuits. Thus a variable frequency wiped back and forth across the reactance curve produces a variable voltage across L-C, suitable for feeding the detector—almost. The signal from W2AG, the 100 watt 2½ meter Armstrong transmitter of Mr. C. R. Runyon at Yonkers, N.Y. has been received in downtown New York with a normal shortwave superheterodyne receiver working "on the side of the characteristic." The fidelity is acceptable, but by no means represents the possibilities of the system, as indicated by many telephone calls to the Empire State building station regarding the allegedly "terrible modulation," which at the time was being received at high fidelity with the proper Armstrong receivers. In these receivers the detector is a balanced device as just stated, the same i.f. output being fed to two R-L-C circuits of which the L-C portions are *not* tuned alike, but are spaced by a frequency-separation about equal to the extreme frequency-excursions of the transmitter. Thus with "resting" carrier both detectors are receiving r.f. input equally, while a frequency shift brings the performance to a point of higher reactance at the input of one detector, and to lower reactance for the other detector. The ballast resistors insuring constant current, it follows that one detector's r.f. input voltage rises while that of the other falls. These rises and falls go on at a frequency equal to the original sound frequency before the microphone, while their amplitude is proportional to the original sound strength—all just as if we had been dealing with amplitude modulation from the start. The push-pull detector arrangement balances out non-linearities due to the non-linear reactance curves of the L-C circuits.

But, still we don't know why the band is so wide! Yes, but at last it is possible to explain. Had a narrow band, with frequency modulation over a limited range, been chosen it would be necessary to design the L-C circuits at the detectors for a steep reactance curve —which is to say, sharp tuning. A noise, and the image of the noise would strike this steep curve at quite different heights and the cancellation between noise and noise-image would be very imperfect, a considerable residual voltage remaining. If the band were 10 kc. wide, then for the extreme case of a 5000 cycle noise we should find its image striking at the L-C resonance and generating no cancellation voltage. For frequencies nearer the carrier the cancellation would be better, but still poor. On the other hand if one is willing to swing the transmission frequency widely to get full receiver-response, then it is possible to use L-C circuits with a "flat" resonance curve (a very slight slope). Such a curve for a 150,000 cycle pass-band is so flat that 10,000 cycles one way or the other makes small difference in its height. Thus a noise even 5,000 cycles from the carrier manufactures an image of practically its own size, and after they have knocked their heads together in the balanced detector system, there is not much left of them. But one must be willing to swing far along that flatly rising curve to get full audio output, and that accounts for the wide band and the multiplier system at the transmitter. The multiplier system might be thought of as gradually converting the original phase modulation into a large frequency modulation—if you care for mental gymnastics.

Practical Results

The current limiter has a species of automatic volume control action. Given an adequate signal from the antenna, the enormous amplification "ahead" will load the current limiter to the "Plimsoll mark" even on the "fade down" of any reasonable signal. No room is left for a "fade up." Even at 85 miles the 2 kilowatt transmitter produced very little fading though a normal 50 kilowatt station nearby (near the 2 kw. Armstrong station) did fade considerably when received with a good broadcast receiver. Other test results are summarized in the table.

It is rather startling to be told that the signal-to-noise ratio is improved about 1000 times as compared with amplitude modulation of a comparable transmitter. The argument on this is about as follows:

If the pass-band for full modulation is 200 kc. wide, then a noise-voltage, as already outlined, cannot be productive of a large net effect upon the detectors because it cannot be heard if more than 10,000 cycles from the carrier (sounds above 10,000 hard to hear), and even 10,000 cycles is but 10% of the swing made by the fully-modulated carrier. As a second factor the comparison between an Armstrong

[*Continued on Page 90*]

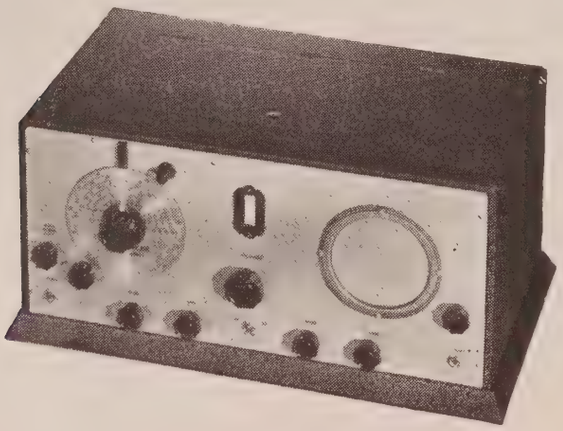
The New S-9 Communications Receiver

[This is one of a series of receivers tested in our laboratory. A complete wiring diagram of this new receiver appears in the offset section of this issue.]

◆

As the first metal-tube amateur-type receiver the Hallicrafters S-9 has been received with great interest, though the use of metal tubes is by no means its main claim to attention.

Both preliminary examination and subsequent tests showed the receiver to be better mechanically and electrically than last year's Skyrider. The changes are more extensive than the outside appearance would suggest. The tube lineup is somewhat similar, but there are important differences, notably the replacement of a pentagrid converter (translator, or "1st detector") by the new 6L7 tube, whose suppressor grid is modulated by the r.f. generated in an independent triode oscillator of the 6C5 type. This combination was fully described on page 17 of October *R/9* and it is pleasing to find that the advantages outlined there seem to have been realized in the S-9. For those who did not see the article we explain that this tube-combination has the advantage of dropping off less than a pentagrid tube in going down to short waves, and in largely avoiding the pentagrid tube's nasty habit of shifting frequency when the volume control is operated, either manually or by a.v.c.



The new metal-tube S-9 superheterodyne.

The 1-stage pre-selector and the 1-stage i.f. amplifier have been retained with the 6K7 tubes replacing the former glass pentodes. The tuned coils have been materially improved in both positions. The r.f. coils are given a better coupling to the antenna by the use of antenna coils which are (for each band) resonant near the longwave end of the band. This improves the "input gain," especially at the longwave side of the band where the usual tendency is to drop off because of the larger tuning condenser capacity. Such action helps the signal to noise ratio, other things being equal.

The i.f. transformers are of the Polydorff iron core type.

The crystal filter has been simplified, the shielding and general action materially bettered.

The 2d detector is a 6H6 diode, to which is coupled a 6K7 beatnote oscillator, whose frequency is controllable from the panel.

The 2d detector of course has three outputs: the audio output, the d.c. output, and the residual rectified intermediate-frequency carrier. The latter is wasted through bypasses in the usual way. The d.c. output is taken through the customary resistance-capacity filter to the r.f., i.f., and translator tubes where it provides automatic volume control action which may be cut out by a shorting switch.

The audio component is resistance-coupled to a high-μ triode (6F5) and then through another resistance coupling to the input grid of a 6F6 output pentode. The volume control is a part of the resistance-coupling system but d.c. is kept out of it for the sake of quiet operation. For the same reason the 6F5 is biased by one of the new "button" dry cells. The use of 2 audio stages offers a considerable advantage in receiving stations with a low percentage of voice or music modulation, and under certain noise conditions. To allow the user to obtain the best performance there is provided an r.f. as well as an audio gain control.

Tuning Changes

The tuning-dials of last year's Skyrider were not altogether pleasing to this reviewer, and the 1936 system is a very great improvement. Without going into fantastic scale-lengths it provides for both good logging and easy reproducibility of settings. The "main" tuning condenser is now at the left where its entire dial is exposed and readable, the pointer automatically being lowered to the proper one of the 5 engraved scales when the band-switch is set. Approximate readings are thus made directly on this dial. On the edge of the same dial is a 6th scale having a stationary vernier sector so that readings are easily made to 1/10 of one scale division (1 part in 1000), which is as accurate as any receiver's ability to retain cali-

bration unless elaborate precautions have been taken, making the cost of the receiver prohibitive for most of us.

Shunted across the "main" tuning condenser is a smaller tuning gang located at the center of the chassis and having a dial with 200 divisions, which may be seen through the rectangular window. This is the "bandspread" dial.

The tuning system accordingly has two distinct uses:

1) Set the "spread" dial at full-scale and use the main dial frequency-calibrations as indicated by the pointer.
2) Set approximately by these calibrations and then use the two dials as convenient. When desiring to record a setting, read the vernier on the main dial and the 0-200 scale on the spread-dial. Experiment shows that such settings are readily reproduced and that the station comes in as set. Both dials have reduction drives of moderate ratios.

To the c.w. man always, and to the phone man frequently, the use of a headset is desirable. In the S-9 the phone jack is "cold" and no shocks are possible. Insertion of a plug (see diagram) opens the voice-coil circuit of the speaker, making it inoperative. The output transformer then becomes a choke of considerable inductance and the signal is deflected through a stopping condenser to the jack, where it enters the headset.

The loudspeaker is plug-connected to the chassis so that an external speaker may be used if desired. This feature has not been shown in the diagram (which would be complicated thereby).

There are 5 frequency ranges as already stated. These are: 0.55—1.5, 1.5—4.0, 4.0—11.0, 8.0—22.0, and 18.0—48.0 megacycles. The operation of the receiver on all ranges was found to be stable, all controls functioned smoothly, the sensitivity was more than adequate for the noise level at this test location (a hilltop in the country), and the mechanical construction seems good.

One additional feature should be mentioned. This is the "send-receive" switch which has been retained from the 1935 receiver, though operating differently. This switch, when placed in the "send" position greatly decreases the sensitivity and makes the set suitable for monitoring. Instead of controlling the monitor-sensitivity from the rear of the set as in the 1935 model, the present receiver has this control placed on the same shaft as the control used during reception.

In the diagram a number of condensers are not marked as to capacitance. These are in all cases 0.05 μfd. If anyone wishes to try "diversity" reception with a pair of S-9 receivers and two antennas at a distance as explained by Carl Roland in this issue of RADIO, it is done by paralleling the condensers marked C_{21} in the two receivers. This is done with a twisted pair and the set receiving the best signal from its antenna acquires enough a.v.c. voltage to knock out the other set and suppress the weaker and noisier signal. When the fadeout passes that antenna the relation may be reversed. The whole business can be stopped by closing the a.v.c. switch to "out" on either set. Then they both do what they can with their respective inputs. But please get the polarities right on that twisted-pair connection or it will not work.

In the beatnote oscillator, C_{35} is the panel-controlled frequency adjustment. If diversity reception is tried on c.w. (which is not too hot an idea) this condenser may need adjustment to prevent some queer effects. This is easy.

Metal-Tube Comparisons

In connection with the RADIO test of the Hallicraft S-9 receiver there was made a listening-comparison of metal-jacket and metal-glass tubes. It is realized that such a comparison lacks the precision of a measurement of output when the receiver is being fed from a laboratory oscillator. On the other hand a listening test exposes some things not readily found by the usual sensitivity and selectivity tests.

As received, the Hallicrafters set carried a full set of Raytheon metallic tubes consisting of the type 6K7 pentode for the r.f., i.f., and beat-note oscillator positions; a 6L7 translator or 1st detector; a 6C5 first oscillator; a 6H6 diode 2d detector; a 6F5 high-μ triode first audio tube; a 6F6 audio output pentode; and a 5Z4 rectifier.

For comparison there was available an almost full set of metal-clad octal-base glass tubes of the so-called "MG" variety, made by Triad. Only the 6F5 was lacking.

Of the R.C.A. metal tubes the types available were not numerous, though we had a number of 6K7 tubes and a number of 6A8's, the latter not useful in this receiver.

It was not anticipated that there would be any observable effect upon exchanging the rectifier, or output pentodes. This was found to be the case, the MG tubes and the metal tubes apparently performing alike.

[*Continued on Page 89*]

"Radio" Contributions

Contributions to our editorial pages are always welcome. They may pertain to any subject connected with amateur, short wave, or experimental radio, or to radiomen.

A small payment is made, usually upon publication, for acceptable material of a technical and constructional nature. This policy has been adopted because we believe the current practice of "chiseling" such material to be unfair to the author, who frequently goes to considerable trouble to correlate the data and prepare the manuscript.

We regret that the funds available do not at present permit payment for material of other than technical or constructional nature, though we appreciate the opportunity of examining it, and the privilege of publishing such as may be found suitable.

Manuscripts should be directed to the home office at Los Angeles except as may otherwise be requested in the current issue immediately following the list of personnel on our staff which may usually be found opposite the table of contents or the editorial page.

What to Write On

We do not suggest subjects on which to write. Write on the subject or subjects which you know best and on which you have the most complete data. In general try to avoid mere "rewrites" of material to be found in standard texts: when such material is needed it can be readily prepared by our staff.

Outlines

Outlines of proposed articles are always welcome. While we do not suggest subjects to authors, we will be glad upon receipt of a detailed outline to express our opinion as to whether or not the material upon which it is proposed to write should be satisfactory for publication. However, because of changing conditions and the fact that outlines do not always end up in the type of article expected, we cannot commit ourselves definitely until we have had time to examine the final manuscript.

"Leads" Appreciated

If you have no article-material which you believe would be of interest perhaps you know someone who has. Such "leads" will be sincerely appreciated by us. If you do not care to send us the name and address of the man with such material, won't you suggest to him that he get in touch with us, or at least that he write us for a reprint of this article?

Make It Complete

Make your story complete; include all the details; give us a complete list of the parts, including both the electrical constants and the trade description of manufactured parts which were used. Never mind the number of words. If it is necessary to cut the article, let us do the cutting. Portions which we believe unnecessary can be very readily cut out. On the other hand, additional information which may be needed means that both you and we must undertake more correspondence. And perhaps the unit described will have been disassembled and the information not available. It's much easier to do a complete job the first time.

Diagrams and Photographs

Include plenty of diagrams and photographs. Diagrams may be sketched in pencil. They need not be fancy, as they will be redrawn by our draftsman. Simply make sure that they are clear and complete.

"A good picture is worth a thousand words," says an old proverb. In radio you can make it five thousand words and be nearer the truth. Let us have good photographs by all means—several of them.

Good sharp photographs, suitable for magazine reproduction *can* be taken by the layman with very ordinary cameras. In fact, by following a few simple rules it is not even very hard to do.

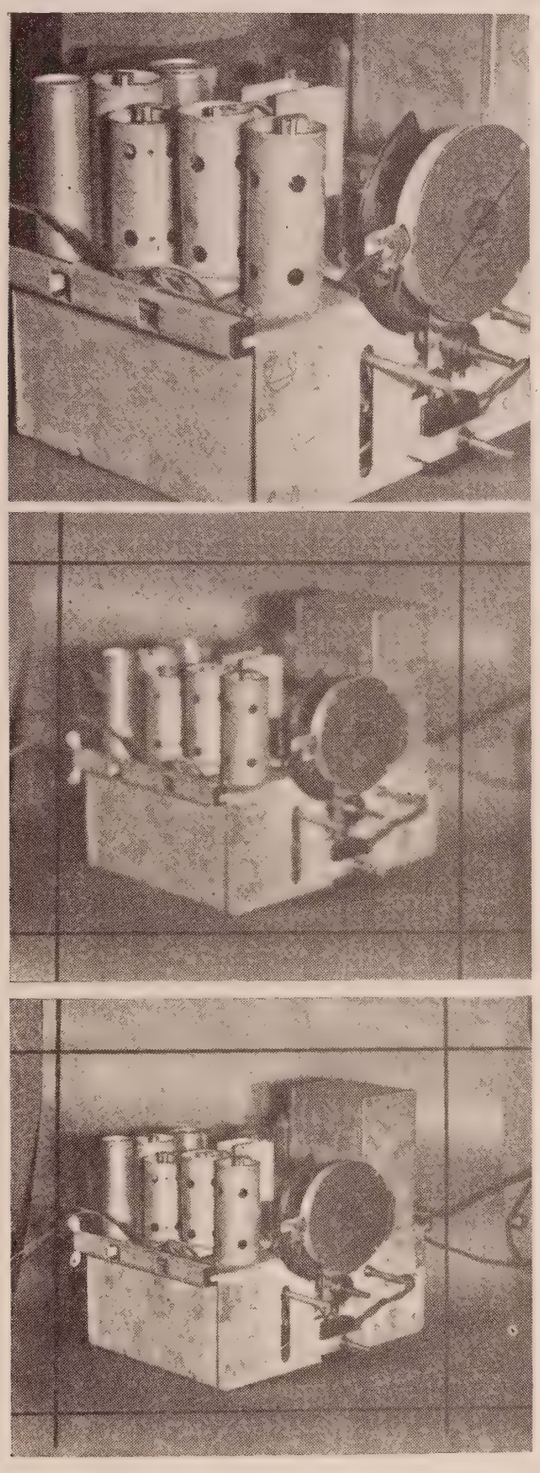
Preparing the Manuscript

Please use your own style. It is not necessary to be extremely dignified. On the other hand, please do not be too colloquial in style.

There follow a few "rules" which will aid us in handling your manuscript. Though compliance with them, insofar as it does not cause you undue labor, will be appreciated, the scale of payment will not be affected thereby.

Please type your manuscript and double space it; leave a margin of at least one inch on all sides; a carbon copy will be appreciated. Underline words which are to be emphasized; do not write them in capitals. Use good, but not "fancy," English and standard punctuation. It will save some labor on the part of our managing editor if you can conveniently follow these abbreviations which have been adopted by us as "standard" for our editorial pages:

v.a., amps., hy., μfd., μμfd., a.c., d.c., r.a.c., a.v.c., q.a.v.c, r.f., i.f., a.f., b.f.o., kc., mc., w.a.c., w.a.z., QRM, QRX, QRA, dx, px, wx, a.m., p.m., e.s.t., c.s.t., p.s.t., G.m.t., db, A.R.R.L., I.R.E., F.C.C., R.C.A. Others will be apparent by analogy.



UPPER

Too bad that such nice lighting, timing, and focus have been spoiled by a messy background, and by getting the camera too close to the subject (4 feet). A part of the set has been cut off and the vertical lines are not vertical near the edges of the picture. Taken on ordinary Agfa film pack.

CENTER

No, this isn't bad focusing. On the contrary this was most carefully focused with a very high-grade anastigmatic lens. It was lighted with 2 photoflood lamps in tin breadpans alongside the camera, which was 9 feet from the subject. As you see there is no distortion of the shape. The general blurriness is caused by using the lens "wide open" and giving a short (1 second) exposure. The image looked beautiful on the ground glass. Same kind of film.

LOWER

Taken from the same viewpoint as the fuzzy picture, same lighting, same film, same distance. In this case the lens was stopped down to f32 and an exposure of 40 seconds made. When working in this way a cheap camera will give about the same results as a good one. If trimmed as shown by the black lines this becomes a good "R/9" illustration—but let us do the trimming. By the way, observe that the background is seamless.

Prompt Decision and Payment

We do not hold manuscripts indefinitely against possible future use. Although we cannot commit ourselves to accept or reject articles within any definite length of time, we endeavor to do so as promptly as the exigencies of other work permit. We cannot hold ourselves responsible for unsolicited manuscripts, but they will be handled with care. Rejected manuscripts will be returned only if accompanied by a stamped, addressed envelope. International reply coupons are accepted from foreign countries.

Ordinarily, payment is made for articles upon publication but when publication is postponed for some reason payment is made as soon as the material has been definitely accepted and set in type.

Scale of Payment

The scale of payments varies from time to time according to the funds available. No definite figures can be given in advance. Authors who wish to protect themselves may specify a minimum price—in fact, they are urged to do so. Frankly the funds available are far too limited for us to make payments commensurate with the "true worth" of such material and the value of the author's "knowing how." We hope, however, that authors will at least feel repaid for their efforts in correlating the data and putting it in publishable form.

Authors should understand that the value of the material to us and consequently the price to be paid is determined not only by the technical validity of their information and the manner of presentation, but also by many factors beyond their control, and some beyond ours. Among these are: the imminence or recent appearance of similar material in this or similar publications; the percentage of readers likely to be interested in the material at hand and their ability to understand it; the necessity of

confirmatory work in our laboratory; the length after editing; and many other factors which need not be enumerated here.

Because of the limited time available we cannot in general enter into extended correspondence regarding material submitted or material which it is proposed to submit, but we will endeavor when practicable to reply to short, to-the-point questions, particularly those which can be answered by a hurried note at the foot of the letter of inquiry and which are accompanied by the usual stamped, addressed envelope.

Taking Apparatus Photos

It is surprising what excellent apparatus photographs a $6 camera can take, but it is much more surprising to see what *bad* ones a $60—or $600—camera can make.

Both portrait photographers and "snapshotters" usually produce bad apparatus photographs, requiring a lot of retouching before a really good halftone "cut" for the magazine can be made from them.

Common Mistakes

Portrait men like "soft" pictures with one-sided lighting. They tend to work with large lens openings, short exposures, and "soft" papers. Unfortunately this is precisely the opposite of the right way to photograph apparatus. A good aparatus photo is so sharp and clear that you can cut your finger on the edge of the metal panel. This does *not* mean a "whitewash and soot" picture, but it does call for long exposure with a *small* lens opening and with even lighting.

"Snapshotters" not only make these errors but also think a *big* picture is necessary and turn up with either a picture taken with the camera so near that part of the apparatus is missed (see top illustration), or a big, gawky, fuzzy enlargement made at the corner drugstore.

The Right Way

Aperture

Use the *smallest* stop (opening) you have. F128 is ideal but since most small cameras will not go down that far, do the best you can.

Lighting

OUTDOORS: Hang 1 or 2 layers of bedsheet, paper or blanket above the apparatus. Behind it, hang a patternless *gray* (not white) cloth, such as a cheap blanket, and wiggle it if possible to keep wrinkles from showing. *Please* make the background bigger than the object—lots bigger. Apparatus never looks just right with part of a Buick or the neighbor's pup peeping in at one corner. A plain concrete wall will serve as an emergency background. Other walls are terrible. So is a batch of bushes.

INDOORS: Wait until night. Use a 40 watt room light to get things set up. Keep it behind the camera and the film will never know it. When everything is organized open the shutter and leave it open. Start and stop the exposure by turning on and off one (better two) "photoflood" lamps in tin or aluminum pans placed a bit back of the camera and to each side, or else very carefully screened if forward of the camera. Have at least one of the photofloods loose so you can wave it around to "wash out" shadows that you see during the exposure. Note that we said photo*flood,* not photoflash. The latter are not worth a hoot for apparatus.

Glare

Bakelite and metal panels are the very devil for causing white glares, which are actually blurry reflections of the lamps. Take 30 minutes to get set up. Try to locate things so that no glares can be seen when sighting over the camera. Sometimes a sheet of tracing cloth in front of the lamp helps; sometimes it helps to pat the glaring panel or tube envelope with a lump of putty, taking care not to "blob" it.

Time

Apparatus is very patient. Set the camera up solidly and *take time* to make the picture.

INDOORS: With 2 photofloods make 4 pictures of each setup, with times of 1.5, 10, and 20 *minutes* respectively. One of these is sure to be right. *Minutes,* not seconds.

OUTDOORS: Work between 10 a.m. and 4 p.m., shade as described, and make 3 pictures. The 1st gets the time given in the table following; the 2d gets twice as much; the 3d gets 4 times as much. One will be right.

Aperture	Cloudy Day	Bright Sky
f128 (ideal)	32 seconds	16 seconds
f64	16 "	8 "
f16	8 "	4 "

Note that on a cloudy day your longest exposure will be from 32 to 128 seconds, depending on the opening. In cameras having no markings, use smallest stop available—if any choice—and assume it is f16.

Development

Tell the drugstore to develop and print *all* of your negatives. If this isn't done your best negatives will be thrown out as being "too hard," since they do not ordinarily deal with the making of halftone "cuts," which always soften a photo. If you do your own developing use the regular Eastman "time and temperature" process and develop fully.

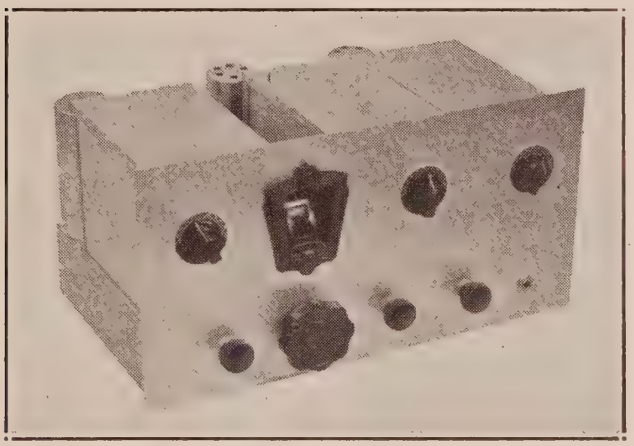
[*Continued on Page 96*]

The "Super Phone Super"

By Frank C. Jones

Remarkable improvement in receiver performance is accomplished in this superheterodyne by use of a duplex i.f. circuit. In addition to super-selectivity as a result of the special band-pass i.f. circuit, it has high sensitivity even on 10 and 20 meters.

The superheterodyne receiver provides more selectivity than can be obtained with regenerative autodyne receivers. The set illustrated uses a special-pass i.f. amplifier to obtain a high degree of selectivity. This arrangement can be used in the crowded



The Jones super-selective receiver

amateur phone bands to give understandable voice quality output. It also gives a nice characteristic for c.w. reception and in actual practice has less interference trouble from strong signals than a regular superheterodyne set with a quartz crystal filter.

The curves of figure 1 illustrate some actual receiver curves. Figures A and C are the curves of the new and expensive R.C.A. AR-60 Receiver with quartz crystal filter cut in and out respectively. Curve B was run in the laboratory on the receiver described here and is of only the i.f. amplifier and second detector. A modulated signal was fed into the grid of the first detector across a 400 ohm resistor from a standard signal generator. This curve was run with some regeneration in the second detector as would be the case for phone reception in the 75 meter band. It can be seen that this curve approaches that of tht crystal filter set but has a wider base so can be used for voice phone reception. At 1000 times (60 db) down, the two curves A and B approach each other and would probably cross at about 80 db down.

This means that this receiver would be as selective against very strong undesired signals as would that one of curve A and a great many times as selective as the usual superhet without a crystal. Strong signals are often 80 to 100 db (10,000 to 100,000 times) greater than a very weak signal and can cause serious trouble in a superhet even with a crystal filter.

On c.w. the second detector oscillates, which peaks up the i.f. characteristic to that of the crystal filter system. Single signal effect is about as good as in the average crystal filter superhet when the 2d detector is slightly detuned. Since there is a high degree of selectivity ahead of this oscillating detector, there is no blocking effect from undesired signals and the gain control can be turned down to allow beat note reception of strong c.w. sig-

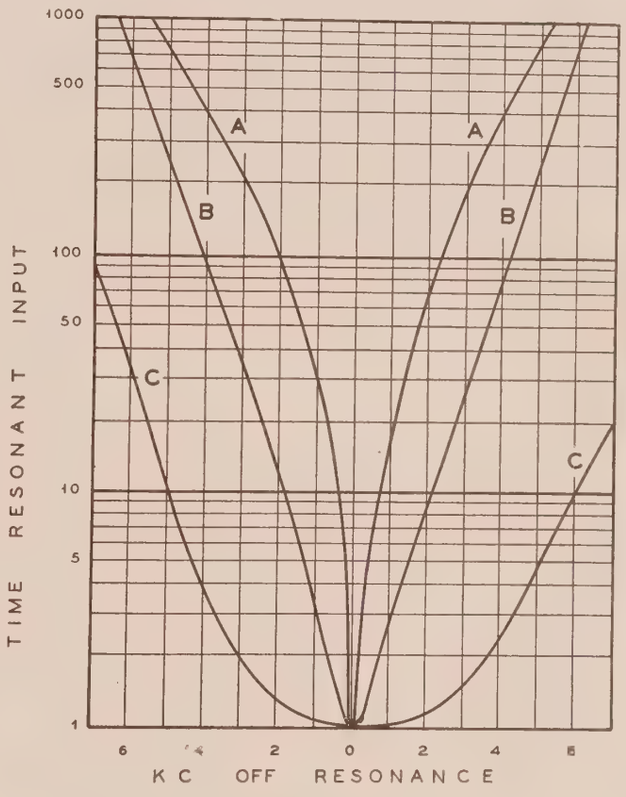


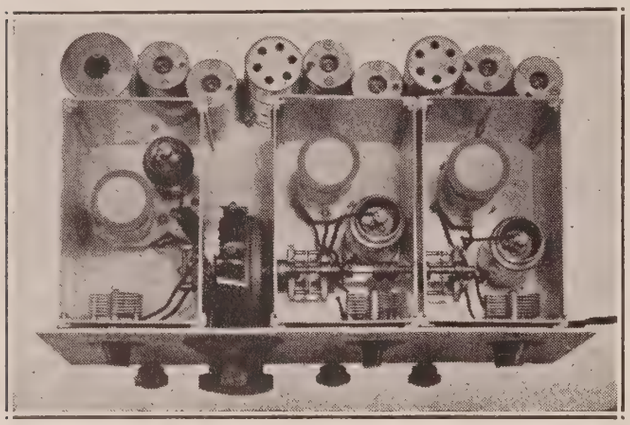
FIG. 1

nals. A 6A6 double triode tube is used as a regenerative or oscillating second detector and audio amplifier for headset operation.

The audio amplifier gives a gain at 500 cycles of about 18 as measured in this set. Low values of coupling resistors are used to limit the gain and prevent motor boating and hum effects. The detector section should be oper-

ated with weak signal input in order to obtain best results of regeneration and oscillating beat note reception. If loudspeaker reception is desired, a 42 pentode audio amplifier can be transformer-coupled to the output of this receiver.

A vacuum tube voltmeter measurement indicated that .04 volts input to the second detector would produce 1 volt across the headset when



Top view showing internal construction

the signal was modulated about 50%. This was without any regeneration. A 15 db gain could easily be obtained with regeneration and by carefully peaking the last i.f. circuit with critical regeneration, 25 db gain over no regeneration was obtained on a modulated signal. This gives a total gain of more than 4000 in the 6A6 tube under certain operating conditions. In an experimental set-up a gain of over 6000 was obtained with good stability and no oscillation in a single 6A6 or 53.

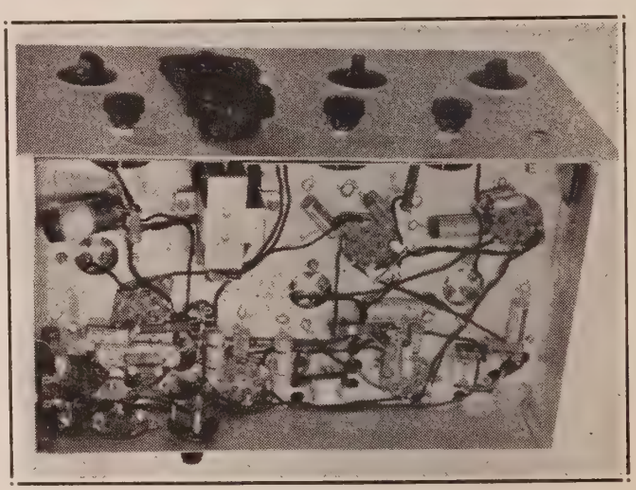
The circuit consists of a 6D6 regenerative r.f. stage, 6D6 first detector, 6D6 high frequency oscillator, two stages of i.f. amplification, and the regenerative 6A6 second detector-audio amplifier. The i.f. transformers are connected so as to have four tuned circuits between each stage. Loosely coupled iron-core i.f. transformers were used because of their superior selectivity characteristics. If air core transformers had been used, about two more transformers would be needed to have the same over-all selectivity. Air dielectric trimmer condensers would be an improvement over mica dielectric trimmers since the circuits have to be set on the peak and should remain at that capacity setting.

The i.f. transformers between stages are coupled together by means of three 30 μμfd. trimmer condensers set at about 5 μμfd. Slightly greater coupling capacity can be used into the last i.f. transformer in order to load the tuned circuit somewhat. Usually the coupling in the last i.f. unit has to be reduced quite a bit to allow second detector oscillation without too much interlock effect.

I.f. oscillation will take place with two stages of iron-cored transformers if the 6D6 tubes are operated at normal voltages. Since the full gain of two stages is not needed, a large fixed cathode resistor holds the maximum obtainable i.f. gain to a value only a little higher than can be obtained with a single stage. Two stages are used simply as a convenience in coupling and to compensate for the "band-pass" circuit losses.

A regenerative r.f. stage provides good sensitivity to weak signals and is especially needed on 10 and 20 meters. Cathode tap regeneration increases the r.f. gain very greatly. The first detector uses suppressor injection from the electron-coupled h.f. oscillator cathode. This system seems to work very well on 10 meters and satisfactorily on the other amateur bands.

The set is built on a 14" x 9" x 2" plated steel chassis with an 8" x 15" x 10 ga. aluminum front panel. The three r.f. shield cans are 5" high, 6½" long, and 4" wide in their outside dimensions, and are made of no. 12 ga. aluminum. A drum dial drives three midget tuning condensers for band tuning. Shunt 100



"Bottoms up"

μμfd. band-setting condensers are individually controlled from the front panel. The r.f. and detector-tuning condensers are rated at 20 μμfd. maximum capacity and the oscillator at 15. The latter (a different type) was used as its direction of rotation is opposite to the other two condeners and also because less capacity could be used in this circuit for gang tuning. Apparently the capacity is nearly 20 in this oscillator condenser as it seems to track fairly well. A little condenser-plate bending and coil-turn squeezing will allow good tracking

COIL DATA

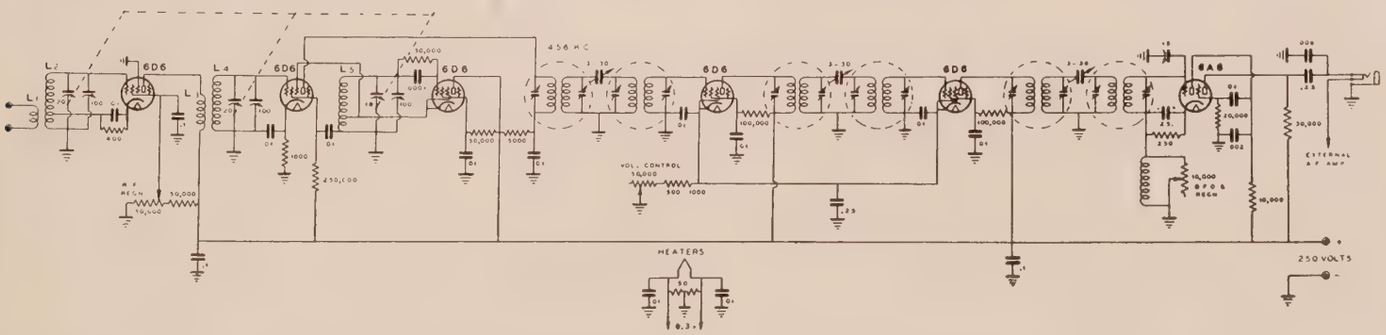
Wavelength	L1	L2	L3	L4	L5
160 meters	12 turns no. 32 d.s.c.	1¾" of no. 24 e. tapped at 1¼ turn closewound	25 turns no. 34 d.s.c. closewound over lower end of L4	Same as L2 no tap	1¼" of no. 24 e. closewound Tap at 2/5 of turns.
80 meters	8 turns no. 32 d.s.c.	38 turns no. 22 d.s.c. 1¾" long. Tap at ¾ turn.	15 turns no. 34 d.s.c. interwound	Same as L2 no tap	32 turns no. 22 d.s.c. 1¾" long. Tap at 10 turns.
40 meters	6 turns no. 32 d.s.c.	12 turns no. 22 d.s.c. 1½" long. Tap at ½ turn.	8 turns no. 32 d.s.c. interwound	Same as L2 no tap	11 turns no. 22 d.s.c. Tap at 3 turns. 1¼" long.
20 meters	2 turns no. 22 d.s.c.	6 turns no. 20 d.s.c. 1" long. Tap at ¼ turn.	4 turns no. 32 d.s.c. interwound	Same as L2 no tap	6 turns no. 20 d.s.c. 1" long. Tap at 1½ turns.
10 meters	2 turns no. 22 d.s.c.	3½ turns no. 20 d.s.c. 1" long. Tap at ¼ turn.	3 turns no. 32 d.s.c. interwound	Same as L2 no tap	3½ turns no. 20 d.s.c. 1" long. Tap at 1 turn.

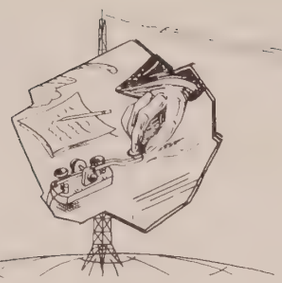
over the narrow amateur bands. The antenna coupling coil has to be capable of slight variation in order to obtain regeneration with different antennas.

The easiest way to build this set would be to use a little longer chassis with r.f. cans 5" wide. The 3-plate condensers could then be mounted on small brackets from the base and driven with flexible shaft couplings. With the construction shown, the shaft line-up is critical for smooth drive and with the particular drum dial shown, the detector (middle shield can) condenser shaft had to be lengthened ⅜ of an inch. The i.f. amplifier is mounted along the rear end of the chassis.

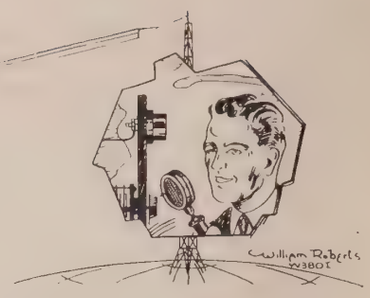
A separate midget condenser with knob control out the rear of the chassis is shunted across the second detector input. This allows oscillation frequency control for single signal effect. Regeneration or oscillation is accomplished by means of a small coil shunted by a tapered variable resistor in series with the cathode circuit. This coil consists of about 100 turns of small wire ¾" diameter over a winding length of about one inch. Too many turns will cause hard oscillation, whereas it should slide into oscillation in a manner similar to an autodyne regenerative detector.

[*Continued on Page 82*]





CALLS HEARD AND DX DEPARTMENTS



Numeral suffix indicates "R" strength. Send Calls Heard to Calls Heard Editor, not to Los Angeles.*

E. H. Conklin, W9FM, 512 N. Main Street, Wheaton, Illinois
October 27 to November 17
(28 mc.)

CX1CG; EA4AV; F8CT; F8KJ; F8VS; G2HG; G5BY; G6DH; G6NF; G6QB; HB9J; JAY; LU9BV; OK1AW; PA0FX; PA0UN; TDC; VE1EA; VE1EP; VE4LK; VE5FC; VE5FU; VE5HQ; VE5HR; VE5PT; VK2HF; VK2LZ; VK3KX; VK3YP; VK4AP; VK4GK; VP5AC; X1AA; X1AM; X1AY; ZL1GX; ZL2KK; ZS1H; ZU6P. — W 1FJN; 2BCR; 2DTB; 2TP; 4AGP; 4AJY; 4BBP; 4CBY; 4CYU; 4EF; 4MR; 5EHM; 6AAA; 6AET; 6ANQ; 6BAM; 6BAY; 6BCO; 6BIP; 6BXX; 6BYU; 6CNX; 6CQG; 6CXW; 6DC; 6DFO; 6DHZ; 6DIO; 6DJJ; 6DOB; 6DYP; 6EPZ; 6EWL; 6FDM; 6FQY; 6GAL; 6GEI; 6GRX; 6HE; 6IHZ; 6INN; 6ITD; 6IXJ; 6JJU; 6JN; 6JNR; 6JO; 6KG; 6KHV; 6KIP; 6KJQ; 6KPR; 6KRB; 6KZL; 6MBS; 6MKL; 6RH; 6SN; 7AEM; 7AMX; 7AVV; 7AYQ; 7BPJ; 7CHT; 7EOF; 7EPT; 7FH; 7TS; 8CRA; 8IXS; 8MWL; 9AGT; 9BPU; 9CES; 9DRD; 9DVW; 9FFQ; 9FLH; 9FUR; 9GFD; 9GHN; 9GYK; 9HAQ; 9ICO; 9KFA; 9MCD; 9MEF; 9NRO; 9NY; 9PK; 9UHE.

Wm. B. Overstreet, W6RH, 680 "A" 9th Avenue, San Francisco, California
October 4 to 24
(28 mc.)

K5AA; K6EWQ; VE40B; VE4KU; ZL3AJ! VK2HZ; VK2LZ; VK3BD; VK3BQ; VK3YP; VK4AP; VK4BB; VK4EI; X1AA; X1AY; X2CC; J2HJ; J3FJ; LU1EP; LU3DX; LU6AX; LU7AZ; LU9BV. — W 1AV; 1AVV; 1CSR; 1DF; 1DZE; 1GSH; 1LZ; 1SZ; 1ZB; 2BCR; 2CFW; 2DZA; 2FDL; 2TP; 3AWT; 3BCF; 3BPH; 3BZ; 3ATF; 3EBK; 3FED; 4AGP; 4AJX; 4AJY; 4AUU; 4EF; 4MR; 5AFV; 5AFX; 5AHS; 5AKF; 5AKI; 5APP; 5AVV; 5BDT; 5BMM; 5COU; 5BMT; 5EEX; 5EHM; 5FAE; 5FFU; 5NW; 5QL; 5WG; 6AAA; 6AWT; 6BAY; 6BNU; 6CAL; 6CIS; 6DGP; 6DIO; 6DHZ; 6ECW; 6BR; 6FWE; 6GHG; 6GTD; 6HKO; 6JN; 6JNR; 6JJS; 6JJU; 6JPE; 6KIP; 6KUF; 6LDP; 6MEZ; 6SC; 6VQ; 6WI; 7AMX; 7AVV; 8CRA; 8DYK; 8DYE; 8FJJ; 8HGW; 8ITK; 8IXS; 8JJW; 8JAX; 8LVR; 8MWL; 9AEH; 9ABE; 9ABP; 9CES; 9CYT; 9DRD; 9DSC; 9DWU; 9DHN; 9DRN; 9BQM; 9FM; 9FFQ; 9GHN; 9GIF; 9GDH; 9GBJ; 9HJA; 9HAQ; 9IJ; 9IWE; 9KPD; 9LF; 9LS; 9MRQ; 9NY; 9NRO; 9PRI; 9PKO; 9PWZ; 9PXJ; 9RGB; 9RKP; 9SI; 9SPB; 9TJF; 9WC.

October 25 to November 6
(28 mc.)

VE3DU; VE40B; VE4IS; VK2EL; VK2HF; VK2LZ; VK3BD; VK3BQ; VK4AP; VK4GK; VK5HG; VK5SU; VK6SA; ZL2GE?; ZL2GQ; ZL2KK; J2IS; J3FJ; J5CE; X1AA; X1AY; X1CM; LU1EP; LU9BV. — W 1AHI; 1AVV; 1DF; 1FJN; 1XAC; 2BQK; 2DZA; 2FDL; 2GJB; 2GLJ; 2HMD; 3AIR; 3BYF; 3DLB; 4AGP; 4AGS; 4AJY; 4AUU; 4CBY; 4DQT; 3EF; 5BDT; 5BXN; 5EHM; 5EUB; 5NW; 5QL; 5WG; 6AAA; 6ATW; 6BAY; 6BNU; 6CAL; 6CIS; 6DGP; 6DO; 6EJA; 6EWC; 6GTD; 6GRX; 6JJU; 6JN; 6JO; 6KNH; 6MVQ; 6SC; 6VQ; 8CRA; 8FJJ; 8IXM; 8IXS; 8JIN; 8KPB; 8KRV; 8LVR; 8LSS; 9ABE; 9ABP; 9AGE; 9ARN; 9BQM; 9BWX; 9CES; 9DHN; 9DRD; 9DRN; 9FFQ; 9FM; 9GDH; 9GHN; 9HAQ; 9HJA; 9ICO; 9IJ; 9KA; 9KPD; 9LF; 9LJU; 9MIN; 9NBI; 9NSC; 9NY; 90GT; 9RGH; 9RKP; 9RGE; 9SCZ; 9TB; 9XII.

Mr. and Mrs. Lloyd Jones, W6DOB-W6AET, 6832 Eleventh Avenue, Los Angeles, California
(28 mc.)

J 3FJ; 2LO; 2HJ; 2IS. — LU 3DD; 7AZ; 1EP; 9AX; 9BV. — VE 4OB; 4QY; 3DU; 4SH; 4TR; 4SY; 3WA. — VK 3BD; 3YB; 3BQ; 4GK; 4BB; 2LZ; 5WJ. — X 1AA; 1AY; 1AC; 2C. — ZL 2GQ; 2KK; 1BA; 3AJ; — CX1CG; EA4AO; EA4AV; F8CT; F8KJ; FA8IH; G5BY; G6CJ; G5WP; K6KSI; ON4AP; VP5AC; ZS1H; ZU6P.

E. H. Swain, G2HG, 31 Woodbastwich Road, Sydenham, S. E. 26, London, England
To November 17
(Received via 28 mc. by W9FM)
(28 mc.)

CX1CG; LU1EP; LU3DD; LU3DH; LU9BV; SU1RO; SU1SG; VE2BT; VE3DU; VK2HY; VK2LZ; VK3BD; VK4AP; VK4BB; VK4ES; VK5WJ; VK6SA; VU2LJ; X1AY; ZS1H; ZT6K; ZU1C; ZU6P. — W 1AV; 1AVV; 1DF; 1DZE; 1FDA; 1FJN; 1SZ; 1ZB; 2BCR; 2CFW; 2DTB; 2GOQ; 2TO; 3AIR; 3BPH; 3BVT; 3BWB; 3BYF; 3DLB; 3EVT; 4AGP; 4AUU; 4BBP; 4CYU; 4MR; 4TZ; 5QL; 7FLU; 8CRA; 8DLA; 8DSU; 8IXS; 8MAH; 8MWL; 9ABE; 9BQM; 9DRD; 9FM; 9HAQ; 9NY; 9SPB.

Eric W. Trebilcock, BERS-195, Telegraph Stn., Tennant Creek, North Australia
August 1 to August 11
(7 mc.)

W 1FKU-3; 1IJI-5; 2CMT-3; 2CMY-5; 2EIL-3; 2EM-3; 2FPL-3; 2GFW-5; 2HEB-4; 2KL-6; 3ADO-5; 3BWE-3; 3CQU-4; 3CRY-4; 3DEI-4; 3DVO-6; 3ELO-5; 3EVW-3; 3FGD-3; 4AIM-6; 4BKH-5; 4BVD-6; 4CBZ-5; 4CFO-4; 4CKM-4; 4CYA-4; 4DBC-6; 5AEP-5; 5AXI-6; 5BTU-5; 5CJJ-4; 5DLD-5; 5JW-5; 5QL-6; 6AUX-8; 6AWY-7; 6BKX-7; 6BQO-6; 6BXU-6; 6CBE-6; 6CHW-5; 6CPM-7; 6CSQ-5; 6GHD-7; 6GPQ-8; 6HVU-5; 6JFJ-6; 6JIH-4; 6JSW-4; 6KBB-4; 6KOF-4; 6KJK-7; 6KZL-6; 6LCF-6; 6LJA-5; 6LBG-5; 6LKU-6; 6LYM-7; 6MFR-6; 6MFX-6; 6MR-7; 6PV-3; 7DBY-6; 7DKY-6; 8ADX-3; 8AXE-5; 8DCG-4; 8FBX-5; 8FGX-5; 8FXF-3; 8HA-4; 8HRD-2; 8HXO-4; 8IHN-5; 8IQB-5; 8KWN-5; 8LVR-3; 8LZK-5; 8MCT-6; 8WO-5; 8ZZM-7; 9BQM-4; 9JL-4; 9KNZ-5; 9LB-6; 9LUC-5; 9MIN-6; 9PDJ-5; 9SDA-5; 9SPB-4; 9UNS-5; 9VAZ-2. — CTAJ-5; CT1DT-3; CT1LZ-4; CT1MS-4; D4GAD-4; D4PBJ-4. — EA 2AA-6; 2AP-5; 3CZ-3; 3EE-4; 3EG-5; 3EV-4; 5CG-4; 7AK-4; 7AO-3; 8AE-3; — EI9D-6; ES5C-4; F3AM-4; F8JD-2; F9KJ-4; F8WK-3; F8TM-4; F8XH-4; FA8BG-3; FT4AF-4. — G 2MI-5; 2NN-4; 2QU-3; 5JM-5; 5XT-4; 6FS-3; 6LX-4; 6QZ-3; 6RQ-4; 6UI-4; 6US-4; 6VP-5. — HC2HP-5; J2KO-7; J2LB-5; J2LK-6; J4CO-7; J5CC-8; K4ACF-5; K4BRN-6; K6EWQ-6; K6KEF-5; K6KVX-8; K6LTZ-4; K6SO-5; K6MEG-6. — KA 1CM-6; 1EE-7; 1HR-7; 1JC-7; 1KG-5; 1LB-5; 1PT-5; 1PW-5; 1XA-6; 9WX-6. — DE7EZ-3; OK1CB-3; OK1WX-5; OK2RS-3; OM1TB-6; OM2RX-7; ON4MT-3; ON4DOA-5; ON4NC-3; ON4ZQ-4; OZ8JB-4; PK1DF-6; PK1DW-6; PK1MD-6; PK1RI-3; PK1TR-5; PK1VH-7; PK4RK-6; PK4XM-6; PA0AD-3; PA0AZ-4; PA0CH-4; PA0FT-5; PA0HC-4; PA0IR-4; PX1A-4; SP1AU-4; SP1TZ-4; U1AN-3; U1BL-4; U3AY-6; U3DM-5; U8VO-5; U0XI-7; UK3AH-4; VE5AV-5; VE5HS-6; VE5NT-5; VQ2WAB-5; VQ4CRH-4; VS1AJ-7; VS6AO-5; VS6AQ-6; VS6AX-5; VU2BY-5; VU2CQ-6; XU2HY-5; XU3FK-5; XU8MT-6; XU8RL-6; XU9Y-6; YL2CG-4; YM4ZO-3.

(14 mc.)

PA0JMW-5; W6CXW-7.

Alice R. Bourke, W9DXX, 2560 East 72nd Place, Chicago, Ill.
September 1 to October 10
(14 mc.)

CO2AN-5; CO2HY-7; CO2LL-8; CO8RQ-7; CO8B-9; CM2FA-7; CM2XF-7; CM7AB-6; CM7JP-5; CX2AK-7; D4GAD-4; D4QET-5; EA3AN-4; EI5F-5; EI8G-5; F8DR-8; F8EO-5; F8TQ-5. — G 2AO-5; 2DC-5; 2IM-5; 2MR-6; 2NM-6; 2QX-5; 2YB-5; 5GQ-6; 5LI-5; 5NI-5; 5RI-6; 5SR-5; 6CL-6; 6LD-6; 6NJ-6; 6OY-5. — GI6XS-6; HC2CH-6; HH2W-6; HP1A-8; K4SA-6; K5AB-5; K6COG-5; LU8BAJ-6; OA4N-5; ON4AU-7; ON4CSL-5; ON4RX-6; PA0XA-5; TI2RC-8; TI5MR-5. — VE 1CD-7; 1DL-6; 1DM-5; 1EA-6; 1HG-8; 2DG-7; 2GA-6; 2GO-7; 2JT-8; 3ADM-6; 4HA-5; 4OG-6; 4PH-7; 4RO-7; 4YL-5; 5LG-5. — VK2EO-6; VK3EG-5; VK5HLY-5; VO1IXP-5; VP1JR-8; VP4TC-4;

*George Walker, Assistant Editor of RADIO, Box 355, Winston-Salem, N. C., U. S. A.

VP5PZ-6; X1AM-8; X1AY-6; X1DA-6; X2C-5; X2GC-5; X2L-5; X2N-6; ZS6T-6.

October 10 to November 10
(14 mc.)

CE2II-4; CE7AA-5; CM2DO-7; CM6DW-5; CX1CX-5; D4ARR-6; G2IN-5; G6MJ-5; G6NJ-5; HI6O-6; K4DRW-5; K5AA-5; K6AUZ-4; K6BHL-6; LU1CA-5; LU4DQ-5; LU7AZ-4; NY2AD-6; OA4N-5; PY1OI-5; PY2QD-5; PY5AG-6; PY7BB-6; SM6UA-5; TI3AV-5; TI5MR-5. — VE 1AQ-5; 1CD-7; 1EP-6; 1HG-7; 2FR-7; 2GA-7; 2HT-6; 2IL-5; 2JK-7; 2JQ-6; 3AFR-6; 3GG-6; 3JZ-6; 3UV-6; 3WA-5; 4AE-7; 4GD-6; 4HM-7; 4JV-6; 4QZ-8; 4TR-6; 4UN-6; 5EC-6; 5GI-5; 5HR-5; 5ND-4. — VK2XU-5 VK3AM-6; VK3HK-5; VK3KS-5; VK3OK-4; VK3SK-5; VK3WW-5; VP2JN-6; VP5JB-6; VP5PZ-6; VP9R-5; X1BA-7; X1DA-6; X1CM-6; X2AH-7; YN1AA-7; ZL2KK-5; ZL2LB-5.

(14 mc. phone)

CX2HA-7; HP1A-7; LU6AP-8; LU7AZ-7; VO1I-6; X1G-5.

(7 mc.)

CM2AZ-6; CM7AB-6; K6LBH-5; TI2FC-5; VE3QZ-6; VE4YO-6; X2A-7; X2R-7; X2U-6.

Basil Sadler, G2AGW, 40, Loxley Road, S. W. 18, London, England
October 2 to October 19
(14 mc. phone)

HC1FG-5; LA1G-7; OE1CM-6; W1KZ-7; W3ZX-6.

(14 mc.)

W 1BLI-5; 1DSH-3; 1FJN-3; 2EKO-5; 2GVV-4; 2HQG-2; 3DCG-7; 3DSY-3; 4CPZ-3; 6JJA-3; 8MWY-6. — CX2AK-4; FA8BG-5; FT4AF-6; K4KD-4; LU1EP-5; LU2AM-5; PY2BA-7; PY2QD-5; SU1KG-8; SU1SG-8; SU2TW-6; TI2CU-3; VE3UG-4; VE4JV-3; VE4NM-5. — VK 2DR-4; 2HF-5; 2HZ-5; 2IC-3; 2LZ-3; 2NY-3; 2RX-4; 2TF-3; 2XU-4; 2ZC-3; 3DP-4; 3MR-6; 3ZW-4; 4BB-4; 4GK-6; 4HK-3; 5FM-3; 5GL-3; 5SU-5; 5WJ-5; 5WK-5; 5ZX-4; 6FO-7; 6LJ-3; 6MN-5; 6SA-5; 7JB-4; 7NC-3; 7RC-3. — VS6AH-5; VS6AX-5; VS6BD-5; VU2CQ-5. — ZL 1DV-3; 1GX-5; 1HV-4; 2BP-5; 2BS-3; 2BX-3; 2BZ-4; 2CI-7; 2GN-6; 2JA-5; 2KK-5; 2MO-3; 2OF-5; 3AB-4; 3AJ-7; 3BJ-7; 3JA-5; 4AO-3; 4BQ-6; 4CK-4; 4GW-5.

R. Roggenbuck, W8IXM, 2972 Garland Ave., Detroit, Mich.
October 1 to October 20
(28 mc.)

W 4AGP-9; 4CYU-8; 5ELL-6; 6CXW-8; 6DIO-8; 6EWC-7; 6INP-5; 6KIP-6; 6KKM-4; 6LGD-6; 6QD-5; 6RH-5; 6SC-6; 6VQ-9; 7AMX-9; 7AVV-8; 7CAT-7; 7EVV-8. — CX1CG-7; G5BY-7; G5FV-5; G5LA-6; LU3DH-6; OA4J-6; VK2LZ-5; X1AY-8; X2C-5.

J. V. McMinn, NZ16W, 12 Edge Hill, Wellington, New Zealand
August 25 to September 28
(7 mc.)

CN8MF; CM8CK; CT1ED; CT1TO; CT1LZ; CT1ET; CT1DT; CT1KG; CT1KR; CT1EG; CT1OI. — D 4ARE; 4ARR; 4BHA; 4CQJ; 4CSA; 4GRF; 4IZI; 4KMG; 4LRM; 4MRL; 4MZP; 4NXR. — EA 1BU; 2BU; 3AB; 3BP; 3CL; 3CP; 3CQ; 3EV; 5BA; 5BK; 5BS; 5CG; 5LE; 7AK; 7AO. — F 3AV; 3CA; 3EY; 3FA; 8AT; 8DW; 8EX; 8JF; 8KJ; 8IK; 8OY; 8PK; 8PQ; 8RQ; 8TC; 8YO; 8YP; 8YW. — FA8PW; FA8WH; G2MI; G2QO; G5JM; G6HW; G6RV; HB9AC; HB9J; HB9M; HB9S; HC2HP; J6CZ; J8CA; J8CD; KA1ME; LU3AI; LU4NB; OA4AB; OE1CM; OE3AH; OK1BC; V; OK2RB; OZ4C; OZ5ED;OK1WX; OK2AC; OK2JJ; OK2M OZ7O; OZ9A. — PA OAZ; ODS; OGA; OJB; OKG; OLR; OMG; ONP; OPN; OPO; OQQ; OUN; OXM; OXZ; OZJ. — SP1AF; SP1CC; SP1DT; SP1IH; SP1MB; SP1MZ; SP1OC; — U 1AN; 1BK; 2NE; 3AU; 3DI; 3DW; 3QR; 4AG; 5KN. — UK3AA; UK3BA; XU8EC; XU8RA; XU8RR; YR5JS; YU7DX.

(14 mc.)

CX1CG; CX2AK; D4MDN; D4MTL; F8EF; F8VP; F8WK; HB9AT; HJ3AJH; J2LK; J5CE; K5AA; K5AO; LU1CA; LU2AM; LU4DQ; LU8BAJ; NY2AB; OA4N; OA4Q; OE1FH; OE7JH; OK1BC; OK1FK; OK1RO; OK2OP; OK3ID; OK3VA; ON4AU; ON4RX; ON4UU; PY1DK; U2NE; U3DS; W2CZV; W4CBY; W4EF; W4FT; YT7AQ.

(14 mc. phone)

PY2BA; TI2RC; TI3AV.

Transatlantic 5 Meter (?) Signals Heard at W3SI

A note just received from Charlie Myers, W3SI, states that 56 mc. has been very "hot" at times, W6DOB being heard, as well as many harmonics from 10 and 20 meter bands, including W5, W6, W9, VP, K4, ON, F, and G. We would say that Charlie is hearing fundamentals and not harmonics if it were not for our knowing that W6DOB has a crystal-controlled rig going on 56 mc.

In addition to the stations now active with high power crystal controlled rigs on "5" we can add ON4AU and G5BY.

We would hate to be "taken in" on this 56 mc. dx question, but it *is* possible, and we have seen a telegram from W2AMJ requesting a confirmation of a two-way phone contact with W9HPH.—*W9FM.*

Stanley Yutz, W8FDA, 115 Mill Creek Ave., Pottsville, Pa.
October 3 to October 27
(28 mc.)

W 2TP; 4AJY; 5AFX; 5BDT; 5EEX; 5EHM; 5ELL; 5JV; 5QL; 6BAY; 6CAL; 6CWX; 6CXW; 6DGW; 6DHZ; 6DIO; 6DLY; 6DOB; 6EWL; 6JJU; 6JNR; 6KIP; 6KPR; 6RH; 6SC; 6VQ; 7AMX; 7AVV; 7AYQ; 7EVV. — D4ARR; D4KPJ; EI8B; FA8IH; F8CT; F8EF; F8OZ; F8VS; G2HB; G2HG; G5BY; G5LA; G6DH; G6NF; OK1AA; ON4AC; ON4AU; PA0QQ; VK2LZ; VK3BD; VK3YP; X1AA; X1AY; X1CZ; X2C; ZS1H.

R. H. Jackson, G6ZU, 54 Prince's Street Stockport, England
September 1 to September 30
(14 mc.)

W 5BZR-5; 5CHO-5; 5QL-4; 5ZF-5; 6CXW-4; 6GAL-3; 6GRX-5; 6QD-4; 7DL-5; 90BX-5. — CE3SR-4; CX1BG-4; CX1CX-5; CX2AK-4; HP1A-6; K5AC-5; LU1AB-4; LU6JB-4; LU7AZ-5; ON4CSL-6; PY2AE-4; PY2BX-4; PY4WR-4; PY5AA-5; PY5AG-5; VE3TA-2; VE4RO-5; VK2ZW-4; VP2BX-5; VP5PZ-5; VS1AJ-4; VS6AX-5.

◆

"Adventure" Cruise

Amateurs should keep an ear cocked for signals from the 40 foot auxiliary schooner *Adventure,* which is expected to set sail from Elizabeth, New Jersey, about the middle of January. The contemplated cruise will take three years, and the tentative itinerary covers 53,000 miles. Aboard the schooner will be Charles A. Powell, Jr., Captain; Fred Boardman, W2CHQ, mate; and Mort Miller, W6HEW, radio operator.

The transmitter uses a 36 oscillator (e.c. or crystal), an 802 buffer, an RK-18 buffer, and a 150-T final amplifier. On phone it is modulated by a pair of 830-B tubes in class B. The input on c.w. is 600 watts, and on phone about 400 watts.

Two receivers have been installed aboard the schooner: one a Breting and the other a McMurdo Silver. Amateurs wishing to contact the *Adventure* should listen for them on the regular commercial ship frequencies.

Practical Series Modulation

By J. N. A. Hawkins, W6AAR

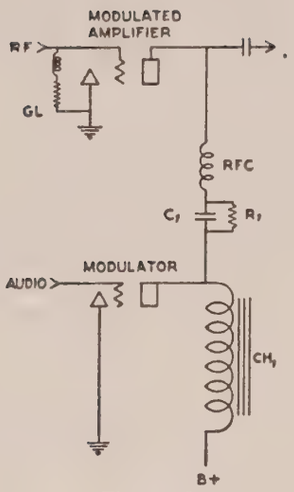


Figure 1

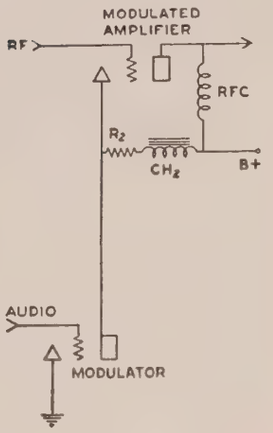


Figure 2

Parallel plate type (Heising) modulation of a class C radio frequency amplifier by a single-ended class A audio modulator was the first widely-used modulation system capable of 100% linear modulation. It has been used during the last fifteen years and still has the advantage of simplicity, if not tube economy.

Plate modulation of a class C amplifier is really power supply modulation and not amplifier modulation. The modulation is effected by swinging the d.c. plate voltage up and down about the normal average d.c. plate voltage present without modulation. During periods of complete (100%) modulation the d.c. plate voltage is swung from normal up to twice normal, then down to zero volts and then back to normal. During this interval the d.c. plate current also varies in an exactly similar manner; from normal up to twice normal, then down to zero and then back to normal. In order to effect this change in plate voltage and plate current, power must be supplied to the normal d.c. plate input to the class C stage. For 100% sine wave modulation the added power equals 50% of the unmodulated d.c. power. From this requirement comes the necessity for having the maximum sine wave audio power output of the modulator equal to one-half of the d.c. plate input. In figure 1 is shown the classical diagram of parallel-plate modulation. The most important point to consider in order to realize 100% modulation capability is the resistor R_1. The purpose of this resistor is to drop the d.c. plate voltage applied to the modulated class C amplifier so that the class A audio modulator may operate at a higher d.c. plate voltage than the modulated amplifier. As the audio a.c. voltage output of the modulator must exactly equal the d.c. plate voltage applied to the modulated amplifier, more plate voltage has to be applied to the modulator because no class A audio amplifier has an audio voltage output equal to its plate voltage. In fact rarely does the peak voltage output of a class A modulator exceed about 80% of the d.c. plate voltage applied to the modulator. Of course, if a step-up output transformer is used in place of the simple modulation choke (CH_1) shown, the modulator and modulated amplifier could operate at the same plate voltage, due to the fact that the audio voltage output from the modulator could be stepped up through the output transformer. However, one of the principal advantages of this type of modulation is that expensive output transformers can be replaced with a cheap and simple choke, so that most applications of parallel-plate modulation use the choke and dropping-resistor method of coupling the two tubes. The condenser C_1 is very important. It bypasses the a.c. audio voltage around the dropping resistor R_1. The whole purpose of the dropping resistor is to cut down the d.c. voltage to the proper value for the a.c. audio voltage present. Thus if the resistor R_1 were not bypassed, the audio voltage would be cut down proportionately with the d.c. voltage. Thus the condenser C_1 must be chosen with regard to the resistance of R_1, so that it offers little relative impedance to the flow of the lowest audio frequency which is to be passed. Usually the size of C_1 will be between 2 and 10 μfds.

Thus remember that with parallel-plate modulation there has to be a device that will drop the d.c. plate voltage to the modulated amplifier without affecting the a.c. plate voltage. In other words, the d.c. plate voltage applied to the modulator must be higher than the d.c. plate voltage applied to the modulated amplifier.

Series-plate modulation is even older than parallel-plate modulation and the fundamental series-modulation circuit merely consists of the modulated amplifier and the audio modulator plate circuits placed in series with each other. Parallel plate modulation was invented merely as an expedient in order to get the filaments of both the modulator and the modulated amplifier

at ground potential. There is nothing magical or mysterious about series modulation. The tube and power-supply costs are almost exactly the same as with parallel-plate modulation. The plate power-supply will have to supply twice the plate voltage at half the plate current for series modulation as compared with parallel-plate modulation, but as the power involved is the same, the costs are practically the same.

Series modulation has never been widely used, because until the circuit shown in figure 2 was developed by the writer no means of obtaining 100% modulation was known. There is no objection to its use except that it is definitely harder to adjust the modulator bias and the modulated amplifier antenna coupling than with parallel-plate modulation. However, this objection would be eliminated if constant current instead of constant voltage power supplies were available.

The series-modulation circuit shown in figure 2 is unusual only in the use of the current-dropping circuit R_2 and CH_2 which is shunted across the plate to filament circuit of the modulated amplifier. The purpose of this shunt circuit is to allow the d.c. plate current through the modulator to be greater than the d.c. plate current through the class C stage. This is necessary because no class A audio modulator can give a peak a.c. current output equal to its d.c. plate current. Thus the d.c. plate current to the modulator must be about 130% of the d.c. current which it is modulating. Therefore the current through the resistor R_2 must be about 30% of the d.c. plate current of the class C modulated amplifier.

It follows that the d.c. resistance of R_2 and CH_2, in series, will be from 3 to 4 times the d.c. resistance of the plate circuit of the modulated amplifier. The purpose of the choke CH_2 is to keep any of the audio current from being bypassed through R_2. In other words, it is necessary to shunt some d.c. around the modulated amplifier but it is essential to avoid losing any audio power in that shunting branch, as that would defeat the purpose of the shunt branch.

It is necessary to point out that there must always be more of the available total plate voltage dropped across the modulator than across the modulated amplifier. In fact, at least 60% of the total plate voltage drop must be across the modulator and about 40% across the modulated amplifier. The use of the shunt branch R_2—CH_2 solves this requirement. Without the shunt circuit across the modulated amplifier it is impossible to have more of the voltage drop across the modulator than across the modulated amplifier. That is so because, for a given plate current, there is always less voltage drop across a low μ class A modulator tube, such as a 250 or 845, than there is across the class C tube that would usually be used with it, such as a 210 or 211. Thus in order to reverse this situation it is essential to shunt the class C stage in order to increase the d.c. current for a given voltage drop, always remembering that the a.c. voltage drop through the class C stage must not be affected by the shunting circuit.

The following circuit constants are typical.

	A	B
Modulator tubes	Parallel 250's	Parallel 845's
Modulated tube	210	211
Plate supply voltage	1000 v.	2000 v.
Voltage drop across mods.	600 v.	1200 v.
Voltage drop across mod. amp.	400 v.	800 v.
Modulator plate current	100 ma.	200 ma.
Class C plate current	75 ma.	150 ma.
Current through R_2 and CH_2	25 ma.	50 ma.
Inductance of CH_2	30 hy.	30 hy.
A.c. load resistance on modulator	5333 ohms	5333 ohms
Resistance of R_2	16,000 ohms (25 watt)	16,000 ohms (100 watt)
Class C plate input	30 watts	120 watts
Mod. peak power output	15 watts	60 watts
Approx. r.f. carrier output	22½ watts	90 watts
Mod. amp. plate loss unmodulated	7½ watts	30 watts
during 100% modulation	11¼ watts	45 watts
Modulator plate loss unmodulated	60 watts	240 watts
during 100% modulation	45 watts	180 watts

Set-up A is for two 250's in parallel, series-modulating a single 210. Set-up B is for two 845's in parallel, series-modulating a single 211. In both cases the load resistance reflected back into the modulators is the d.c. plate voltage divided by the d.c. plate current (in amperes) of the modulated stage, which is 5333 ohms. This load is about right for the modulator tubes used. Note that the resistance of the shunting branch across the class C modulated amplifier is not reflected back into the modulators, as no audio power is dissipated in it and thus it does not load the modulators.

The modulator tubes are being run slightly above their ratings, but not sufficiently so to

[*Continued on Page 82*]

Contest

"Radio" is convinced that there are dozens of capable authors in the amateur ranks who have insisted upon "hiding their light under a bushel basket" and, as potential authors, need particular coaxing or incentive to rouse them to the extent of "taking pen in hand". We are therefore sponsoring a contest for the express benefit of these shy, retiring amateurs.

The rules of this article contest are as follows:

1) *The contest is open to anyone who has had no feature-length article published in* R/9 *or* Radio *since July 1, 1934.*
2) *The article must be technical in scope to qualify; constructional articles will be given more "points" than non-constructional articles of the same merit. Photos count 25%.*
3) *Manuscript must be postmarked by March 30th.*
4) *All articles accepted for publication will be paid for at regular rates without regard to the contest.*
5) *The author of the article that is chosen as best of all entries submitted will receive, in addition to payment for the article at regular rates, a bonus of $50.00.*
6) *No rejected manuscripts returned unless accompanied by a stamped, addressed envelope.*
7) *The members of the* Radio *technical staff will act as judges. Their decision will be final.*
8) *The story must be original and must not have appeared in other periodicals.*
9) *We reserve the right to declare "no contest" should not more than two entries suitable for publication be received and accepted at regular rates.*

◆

Pipe cleaners and dry paint brushes are f.b. tools around the ham shack. The pipe cleaners have no equal for taking dirt from between condenser plates, and the paint brush for dusting complete chassis, etc. The brush will get into nooks and corners where the dust cloth never could. For a real job, and a quick one, of dusting radio equipment there is nothing like an air hose; and we saw one very fine system made up ham-fashion by attaching the usual sort of bicycle tire pump to a large air-tight can through the necessary valve. Considerable pressure is built up in the can and by means of a valved hose attached to the business end, a lot of dust blowing and quick-cooling can be carried on.

◆

Many hams who are confronted with the problem of beautifying a transmitter that must stand in the living quarters of a house have overlooked the new modernistic chests of drawers, which are f.b. for the purpose.

Above is shown the unusual 75 meter beam antenna of W9PZ. It is "aimed" merely by punching the proper push-button at the operating position inside the station. The vertical duraluminum poles are the ¼ wave vertical antennas. The wood poles in the foreground support the transmission line and the control wires.

◆

The F. C. C. has circulated a memo among the holders of experimental station licenses calling attention to the inadvisability of allocating ultra high frequencies to commercials at the present time. The Commission points out that experimental results obtained so far do not warrant such allocations. As a result, the licenses of all experimentals operating on frequencies above 30,000 kc. have been extended through the next license period, which expires October 1, 1936, and the Commission hopes that by that date sufficient quantitative data may have been submitted to justify commercial ultra-short wave allocations.

All of this means, at least, that we had better begin expecting commercial neighbors on the ultra high frequencies. As with the "short waves" a little over ten years ago, we may again be developing a fertile field for commercial interests.

Harwood Exciter Note

The terminal post marked "B–" in the diagram of the Harwood exciter described in December *R/9* should read "B– and Ground". This should have been obvious from the circuit, and it is usual practice to ground the B– anyhow; but evidently it was not apparent to some of our readers, as several letters were received regarding non-operation of the exciter. Hereafter we will check more closely to make certain a ground on the B– is indicated whenever such should be the case.

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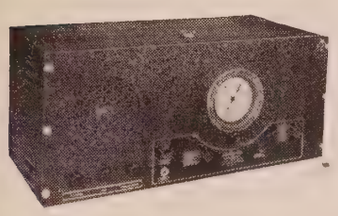
For a long time now "R/9", "Radio", and the Wholesale Radio Service Co. have been serving the needs of amateurs. Just as you have come to feel that this is YOUR magazine so WE want you to feel that this is YOUR company. Amateurs who look for quality at lowest possible prices naturally gravitate to the world's largest amateur servicing organization. Make this YOUR headquarters, just as have scores of leading manufacturers—a few of whose products are presented below.

LAFAYETTE "Professional 9"



Available in kit form but with coil-switch assembly completely wired and tracked at the factory. Features preselector on all bands; powerful oscillation at the highest frequencies; 4 separate wavebands from 9.7-560 M. YY22069. Price complete kit less tubes and cabinet. **$36.75**

If wanted completely wired add $7.50
Cabinet extra $7.50

LAFAYETTE 5 Meter Superhet

Featured editorially in "R9" October 1935 issue. Any ham can build it. Features increased sensitivity; improved selectivity. No super-regenerative rush. Here's a superhet receiver that will warm your heart at our low price. YY22098. Complete kit of parts including cabinet, and chassis but less power supply, tubes and speaker..... **$18.25**

Kit of matched tubes (1-6C6, 3-6D6, 1 41, 1-42) $3.20
For factory wired receiver, add $1.25

"Band Spread" Portable

Combined s.w. receiver and monitor. Completely self-contained including batteries and coils. Smooth, noiseless regeneration. Uses special "band spread" coils for 20, 40, 80 and 160 M. amateur bands and 19, 25, 31 and 49 M. broadcast bands. **YN13960.** Complete kit of parts less coils, batteries and tubes (2-30's). **$7.95**

Set of 4 coils (either Ham or Broadcast bands) $2.10
If wanted wired, add $1.95

HALLICRAFTER *Super Sky Rider*

With new metal tubes. Nationally known and advertised. Our price with tubes but less crystal. **YN13768.** **$79.50**

Available with factory installed crystal. **YN13767** $89.50

Hammarlund Chokes

are popular among amateurs.
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Nothing else to buy. Complete, ready to use with tubes, power supply, speaker, etc. **YN13814. Your Cost** **$69.50**

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Set of tubes (1-30, 2-19's) $1.73
Set of Burgess batteries $3.77

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New High frequency "Low C" tube. Fits standard 50 watt socket. **Your cost** $24.50

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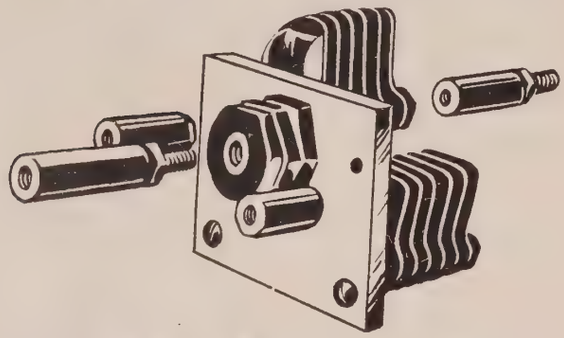
We've heard of mail being received two, three, and even five years after it was sent. But RADIO claims the prize; its editorial offices have just received the October, 1636 issue of *Amateur Radio* (Australia)!

Another

CARDWELL WINNER



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CONDENSERS

The "Super Phone Super"

[*Continued from Page 75*]

Alignment of the i.f. system is a little difficult since each circuit has to be peaked accurately at about 456 kc. A test oscillator should be coupled into the individual transformers starting with the one feeding into the second detector. As each transformer is aligned, the oscillator lead can be capacitatively coupled to the next preceding transformer until the whole system is lined up to the desired i.f. frequency. The r.f. circuits can be lined up by means of the same oscillator, if it happens to be an all wave type. When proper alignment is obtained, phone signals that would ordinarily be unreadable on a conventional "sharp" superheterodyne can be copied with ease, though the fidelity may be impared very slightly due to clipping of the higher frequency sidebands.

◆

Series Modulation

[*Continued from Page 79*]

shorten their life appreciably.

The principal advantage of series modulation is the avoidance of the modulation choke, which greatly simplifies the problem of wide-range response as is necessary for television work. For amateur work an ordinary filter choke of sufficient inductance will permit flat response over a sufficiently wide range for voice reproduction. Because the choke is not such a big item in this case and the cost is low, the choke-saving feature of series-modulation is mostly offset by the extra filament transformer required.

◆

The use of a 10-volt Rectox voltmeter as a modulation meter which reads directly in per cent modulation is fully described in Westinghouse pamphlet F.8310. Any ham may obtain this booklet for the asking. Address Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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1000 Watts at 5 Meters with

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RATING AND DATA
HF200

FILAMENT:
Voltage .....10-11 Volts
Current .....3.4 Amps.

GEOMETRIC CHARACTERISTICS:
Amplification Constant- 18
Inter-Electrode Capacities:
Grid to Plate.....5.8 MMF.
Grid to Filament.....5.2 MMF.
Plate to Filament.....1.2 MMF.

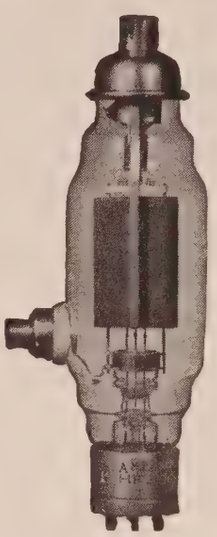
MUTUAL CONDUCTANCE 5000 Micro-Mhos
at Plate Current of 150 MA.

MAXIMUM OPERATING RATINGS: when used as Class C Oscillator or Power Amplifier at frequency of 60 megacycles.
Allowable Plate Dissipation .....150 Watts
2500 V. A. C.
Plate Voltage.....2000 V .D. C.
Plate Current.....200 MA.
D. C. Grid Current..... 60 Ma.
D. C. Grid Bias Voltage.....350 VOLTS
Attainable Plate Power Output ....250 to 350 WATTS

SUCH are the design characteristics and efficiency of the Amperex HF300 Tubes that in suitably designed circuits a pair of them will deliver a 1000 Watt Plate Power Output at 5 meters. Their remarkable performance has been made possible by the design characteristic which gives these tubes the distinct advantage of possessing the highest ratio of Transconductance to Interelectrode Capacitance yet attained in any tube. This characteristic in combination with their high mu reduces the requirements for grid excitation to a minimum.

These new Amperex tubes are proportioned along conventional lines. There is nothing freakish in their structure or appearance. In their design is incorporated the latest engineering practice and knowledge of ultra-high frequency operation.

Such has been the successful acceptance of the Amperex Ultra-High Frequency Tubes that some of the major competitive manufacturers have copied in detail their design and structure.



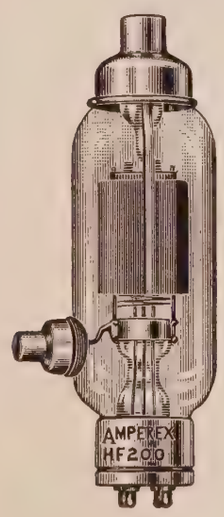
RATING AND DATA
HF300

FILAMENT:
Voltage .....11-12 VOLTS
Current .....4 AMPS.

GEOMETRIC CHARACTERISTICS:
Amplification Constant- 23
Inter-Electrode Capacities:
Grid to Plate.....6.5 MMF.
Grid to Filament.....6.0 MMF.
Plate to Filament.....1.4 MMF.

MUTUAL CONDUCTANCE 5600 Micro-Mhos
at Plate Current of 150 MA.

MAXIMUM OPERATING RATINGS: when used as Class C Oscillator or Power Amplifier at frequency of 60 megacycles.
Allowable Plate Dissipation .....200 WATTS
3000 V. A. C.
Plate Voltage.....2200 V. D. C.
Plate Current.....275 MA.
D. C. Grid Current..... 75 MA.
D. C. Grid Bias Voltage.....400 VOLTS
Attainable Plate Power Output ....400 to 600 WATTS



A partial list of Amperex tubes suitable for Amateur and Experimental work is listed below:

	Watt Plate Power Output	
HF300	500	$35.00
HF200	400	24.50
211-H	175	17.50
203-H	175	17.50
211-C	150	17.50
211-D	150	15.00
830-B	50	10.00
801	25	3.25
872-A	Mercury Rectifier	17.50
866	Mercury Rectifier	2.25
866-A	Mercury Rectifier	5.00
852	Mercury Rectifier	16.40

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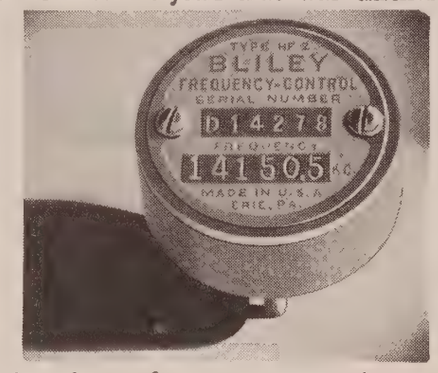
What's New

20 Meter Crystals

Over a year ago Mr. H. E. Blasier of the Monitor Piezo Electric Company awed one of RADIO's editors by showing him a 20 meter crystal that was thicker than a 40 meter X cut crystal. What is more, it proved to be a very active oscillator. It is explained that several of these specially cut 20 meter crystals had been "on the shelf" for several months and probably would remain there for many months to come. It was not desired to release them for a very good reason: at that time activity on 10 meters was almost nil, and therefore these crystals would be used mainly for "straight through" 20 meter operation. Operating straight through (crystal on operating frequency) is not to be recommended with 40 and 20 meter crystals unless elaborate precautions are taken to guard against feedback into the crystal stage and resultant high crystal current. Therefore for 20 meter operation it is advisable to use a 40 meter crystal and frequency doubler, rather than a 20 meter crystal.



Increased activity on 10 meters has created a demand for 20 meter crystals, and in answer to this demand, dealers are now being stocked with these thick-cut 20 meter plates. These plates are quite active, have single frequency response, and have a positive temperature coefficient of 20 cycles per million per degree Centigrade. The output is comparable to that of a 40 meter X cut plate.

Special thick-cut 20 meter plates are also being manufactured by the Bliley Electric Company.

In an early issue will be shown practical application of these new 20 meter plates, giving circuit diagrams, operating constants, and other data.

New Velocity Mike

Two types of velocity microphones for direct connection to the grids of vacuum tubes have been announced by the Bruno Laboratories. The amateur type is flat within 2 db. from 60 to 10,000 cycles, and the sensitivity is claimed to be greater than that of a carbon two-button microphone. The development of these new microphones was made possible by the use of "Nicalum", a new high-permeability alloy with a magnetic strength four times as great as the best magnetic metal heretofore obtainable.

Both the amateur and broadcast types are available in either 5,000 or 100,000 ohm output impedance.

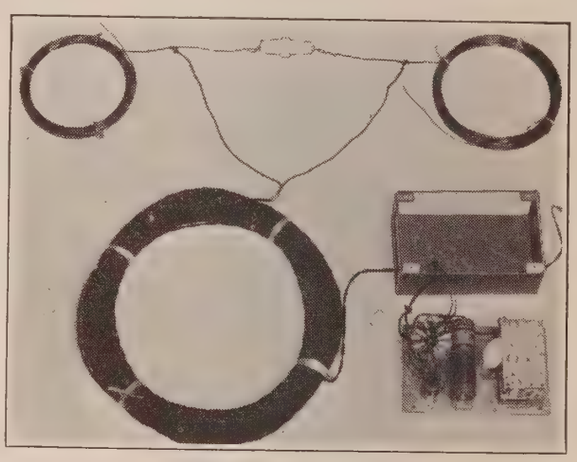
Ultra Midget Electrolytics

Amateurs are now familiar with *"little giants"*, the ultra-compact midget dry electrolytics introduced by Solar Mfg. Corp. some months ago. Reduced to a startlingly small size, for equal capacity and voltage ratings they need only about half the space required by so-called "midgets".

"Little giants" of the dual type are now offered. This series affords the same space-saving economy, and offers lower cost than buying two singles, with increased convenience through flange mounting. They are made with separate sections and with leads from each section, so connections may be arranged to fit any circuit layout.

Tuned Antenna Kit

The McMurdo Silver Corporation offers an antenna kit which permits tuning of the r.f. transformer at the lower end of the twisted-pair transmission line descending from the center of the doublet. There is no transformer at the upper or antenna end of the line. The intention is to tune the system as a whole over three wavelength ranges, each covered by one r.f. transformer and stated to cover the range from 9 to 200 meters in wavelength. The appropriate transformer is selected by a switch. A fourth position of this switch eliminates the transformers and connects the line itself to the receiver in the manner so much used in broadcast reception at short waves. A fifth switch position leaves one side of the line open (apparently) while leaving the other side connected to the antenna post of the receiver whose ground post is simultaneously connected to ground. This is actually a Marconi T antenna system since the two halves of the antenna are placed in parallel by the inter-wire capacity of the transmission line. This arrangement has been used with success by several broadcast-receiver makers, for the wavelengths above 200 meters.



New Tuned Antenna System

The merit of tuning either the antenna system as a whole or at least the load into which a transmission line from an antenna delivers its signal can hardly be questioned. If the operator is willing to make one additional non-critical adjustment he may expect an improved signal-over-noise ratio at the least.

BOOK REVIEW

New A.R.R.L. Handbook

THE RADIO AMATEUR'S HANDBOOK, 1936 Edition, by the A.R.R.L. Headquarters Staff. 480 pages, with 500 diagrams, charts and photographic illustrations. Published by the American Radio Relay League, West Hartford, Conn., U.S.A. Price, paper binding, $1.00 postpaid in U.S.A. and possessions, elsewhere, $1.15; buckram binding, $2.50 in all countries.

The present 1936 edition of the *Radio Amateur's Handbook,* published by the American Radio Relay League, is the completely revised and greatly enlarged successor to the previous series of 12 editions.

The opening chapters on the history of amateur radio and getting started are up-to-the-minute, with new illustrations. The electrical and radio fundamentals chapters are completely new treatments serving as the foundation for the thirteen apparatus chapters which follow.

An entirely new 30-page chapter on vacuum tubes contains the most comprehensive tabulated tube data ever published, including 10½ pages of rating and characteristic tables for all types of metal and glass receiving types, as well as for transmitting and special-purpose tubes, supplemented by practical information on operating characteristic determinations and applications. The new receiver design chapter contains a wealth of circuit features described in concise, practical detail.

In the chapter devoted to transmitter design, the theoretical and practical considerations involved in transmitter circuits are given sectionalized treatment. Only modern transmitters are described, including multi-band models with coil switching. An enlarged chapter on keying methods is followed by a chapter on the principles of modulation and fundamentals of radiotelephony circuits, from microphones to controlled-carrier systems.

Ultra-high-frequency communication has two chapters devoted to it, telling how super-regenerative receivers work, and how to build them, describing super-hets and the new super-infragenerator receiver. The u.h.f. transmitter chapter is a practical treatment of proven circuits, from the simplest self-oscillator through linear oscillators and oscillator-amplifiers.

Power supplies are treated in greater detail than ever, covering receiver-packs, voltage dividers, and supplies for grid-bias, as well as all the standard rectifier-filter equipment.

Antenna design is especially complete. Numerous charts facilitate the planning, from simple single-wire antennas to complex directional arrays; transmission-line design being given particular attention. A new chapter is devoted to instruments and measurements, including cathode-ray oscilloscope. The chapter on station assembly illustrates new arrangements which the new equipment has made possible. Communications Department chapters give complete information on good operating practices and field organization set-up.

R.C.A. Cathode Ray Book

CATHODE-RAY TUBES AND ALLIED TYPES, issued by the R.C.A. Radiotron Division, R.C.A. Manufacturing Co., Harrison, N. J.; 120 pages, paper cover, price 25c.

This booklet is something between a catalog and a text. The first 68 pages contain assembled data on the tubes made by R.C.A. for cathode-ray work. The second half of the book consists of practical instructions in the operation of cathode ray including in-

[*Continued on Page 86*]

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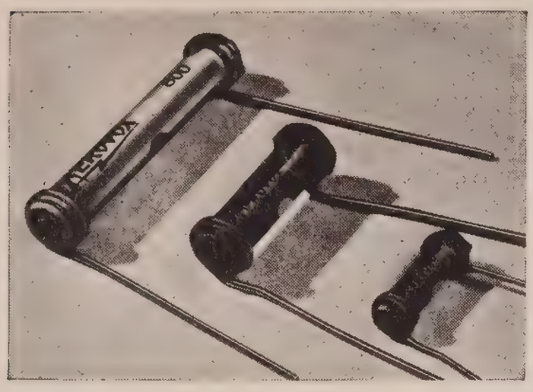
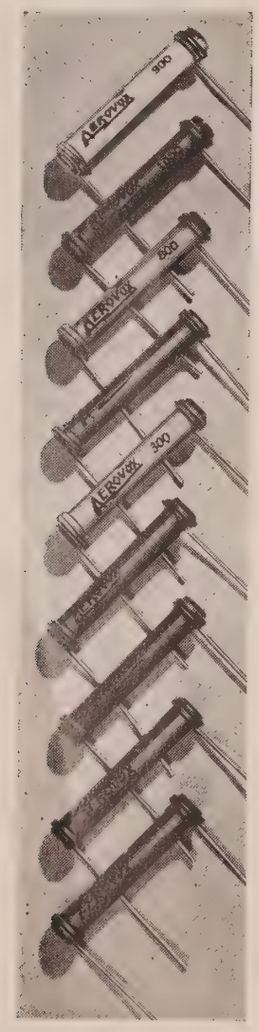


CARBON RESISTORS



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Solid molded carbon element. Non-fluctuating. "Noiseless."

Accurate values (within 10%) as plainly stamped and R.M.A. color coded.

Non-inductive (no appreciable change at h.f.). Non-hygroscopic (unaffected by moisture).

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DATA New condenser and resistor catalog now available. Send for copy; also sample of Research Worker. Meanwhile, contact the AEROVOX jobber for those better radio parts.

AEROVOX CORPORATION

84 Washington Street Brooklyn, New York

[*Continued from Page 85*]

structions for building an oscilloscope around the popular 3″ tube; also power supplies, timing-wave generators, and suitable amplifiers. Interpretation of the figures obtained on the screen, with special reference to modulated r.f. amplifiers (in voice transmitters), is discussed briefly, as is the use of the cathode-ray tube for aligning receiving amplifiers. There are also some concise and very useful instructions for photographing the patterns—the camera plus the oscilloscope then becoming an oscillograph.

Radio Communication Text

PRACTICAL RADIO COMMUNICATION, by A. R. Nilson and J. L. Hornung. Somewhat over 750 pages; leatherette binding; McGraw-Hill Book Co., 330 West 42nd Street, New York; $5 postpaid.

To this reviewer *Practical Radio Communication* seems an excellent text book on the subject. This in no way discounts the book for those operators who can apply clearly stated principles to practice, while on the other hand this does free the book of many pages of data and constants such as we expect to find in so-called "handbooks".

The authors have recognized that some readers wish to learn only about equipment for one type of service, as for instance broadcast equipment. For this reason notes have been provided at intervals to suggest jumps over material which is (for that particular reader) unimportant at the moment. The 435 illustrations are well chosen and well done. The equipment discussed is of recent types and in a reasonable proportion of the descriptions the circuit constants are stated wholly or in part.

Fault can always be found, of course. This reviewer, for example, would prefer to see somewhat more specific and complete material on frequency multipliers, the grid-excitation requirements of power amplifiers, the output ripple of smoothing filters, ohm-meters other than the simple series variety, and other sending tubes additional to those of Western Electric and RCA—with all respect to those two makes. But another reviewer might find these very topics over-discussed. Nor is it of any serious import that the authors have followed the fashion of referring to the Gutton-Touly oscillator as a 1919 development, though it is but an obvious short wave form of the old American ultraudion circuit.

It is a hundred times more important that an excellently chosen variety of sending and receiving equipment for all important commercial uses—land, sea, and air—has been set forth on a goodly foundation of theory and practice. McGraw-Hill Book Co. is taking no gamble in offering the book on 10-day inspection.

Transmitter Guide

AMATEUR TRANSMITTERS, 32 pages of large size, with 19 large diagrams, paper cover. Distributed by the publishers: Standard Transformer Cop., 850 Blackhawk Street, Chicago.

This is a very useful type of manufacturer's literature and must be of help to transmitting amateurs on more than a few occasions. There are shown 9 transmitter circuits of various powers, together with circuits for the power supplies to drive them, and also for the speech equipments if voice operation is desired. Constants are stated in all cases, and type numbers where necessary.

Amplifier Guide

SOUND AMPLIFIERS, 24 pages of large size, 12 large diagrams, paper cover. Distributed by Standard Transformer Corporation, 850 Blackhawk Street, Chicago.

11 amplifier circuits with constants are shown. The range is from a 30 watt amplifier down to microphone pre-amplifiers and hearing-aid amplifiers. A very useful book.

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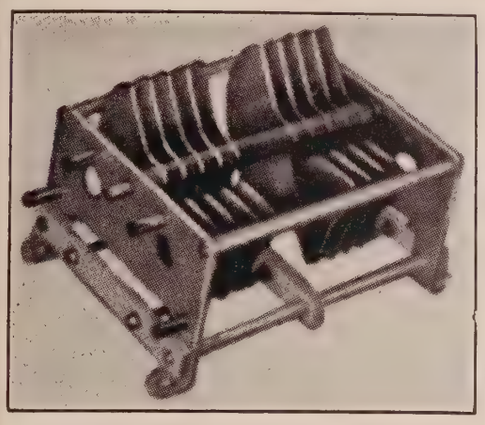
When it comes to giving values LEEDS always Leads the field. A host of friends throughout the world know this—and many more are joining our happy family daily. It pays to deal with LEEDS.



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There is a satisfied LEEDS customer near you, regardless of your QRA. LEEDS export service is being used constantly by amateurs and professionals in 70 countries. One shipment will convince you.

If you are building or rebuilding in the modern rack and panel manner, take a look at our December "ADVERTISEMENT" for lowest prices on constructional accessories.

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LB-10 900 v. center tapped at 150 MA; 5V-3A; 2½V-10A; LB mtg..... **$3.25**

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LA-50 12 H., 500 MA; D.C. res. 70 ohms, LA mtg..... **$6.50**

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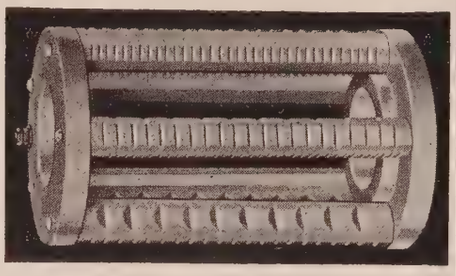

VITROLEX Universal Coil Form; diamter 4", length 6¼"; grooved for 10-20 and 33 turns. Just rotate the spacing bars a quarter turn and you have a new form. Ideal for use on all ham bands. Price..... **$1.50**
Bars separately **25c** each.

NEW GIANT BAKELITE plug-in coil forms; ribbed barrel, 2½" diameter, winding space 2¾"; four five and six prong; each..... **45c**

LEEDS Leads as the only distributor in the country, handling GENERAL RADIO Amateur accessories and laboratory apparatus. Bulletin No. 936 mailed on request.

LEEDS Oil Immersed Filter Condensers. Cased units of unusual quality at prices made possible by quantity buying. 2 mfd. capacity only.

1000 v.	1500 v.	2000 v
$1.45	**$2.00**	**$2.45**

EXCEPTIONAL VALUE — Westinghouse two wire 110-120 volt, 60 cycle kilowatt hour meters; five or ten ampere capacity. Specially priced at **$3.50**
Shipping weight 15 lbs.

TOBE KITS IN STOCK

The finest low cost communication receiver on the market. Complete kit..... **$41.40**

Wright DeCoster 8" speaker in metal cabinet **$4.90**

Receiver cabinet..... **$4.80**

Complete kit RCA tubes..... **$3.32**

Wiring and testing for lazy hams, including single signal reception with regenerative I.F..... **6.50**

A thin dime brings our bulletin B-73 together with data on all of the products of 25 nationally known manufacturers.

Our Bulletin B-73 contains complete descriptive matter on all LEEDS APPARATUS including our new transmitter units.

Rambling through the classified ad section of an aged radio magazine t'other day, we came across an ad offering two burnt-out five-watt transmitting tubes at two bucks each.

The only Speaker with Armored Field Coils.

QUAM SPEAKERS

ONLY skilled operators, experienced in delicate electrical assembly, build the precise voice coil units of Quam Speakers.

QUAM-NICHOLS CO.
1623 W. 74th Street, Chicago
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30 9th Street SAN FRANCISCO
303 E. Pike Street Seattle
209 W. 17th Street Los Angeles
3037 Knox Avenue, S. Minneapolis
"AMERICA'S LARGEST SPEAKER MANUFACTURERS"

Walter A. Parks

With no intention of disrespect we say with the *Washington Daily News*, Walter Parks was "a splendid engineer and a great guy". That healthy American title is given to those who have earned it by gaining the respect of their daily companions.

We remember Walter also for his fine work at the time of the pioneer transatlantic flight of the NC boats during which his particular ship, aided by its radio contacts, made an amazing 200 mile surface-journey to Ponta Delgade after flight had become impossible. We remember him also for the exquisite radio devices of the National Electric Supply Company, for engineering work at the Naval Research Laboratory and for the National Broadcasting Company. Woven through all this is an unremitting interest in amateur radio communication, such that to write the story of W3ZW and its predecessors would be almost to write a history of amateur radio communication by key and voice, from the spark coil to the present day with the clear, strong signals of Walter's station always coming from equipment well made, and splendidly handled. As in his other work—the job was always well done. It was good to have known him.

◆

Five-meter ops. in the Boston area are particularly fortunate in that two ultra high frequency broadcasting stations operate near enough to the five meter band limits to be good markers. W1XKA, ultra short wave outlet of WBZ, transmits on 55.5 mc. and W1XAV, ultra short wave outlet of WNAC, on 60.1 mc. Incidentally, both of these stations have considerable carrier power and are anxious to receive dx reception reports, if there be any.

◆

There has been consternation in the ranks. The recent Radio Laboratories of Kansas City contest was announced in an advertisement in *QST* but the same page in copies of the magazine received on the East Coast carries a "Handbook" ad.

"H C" CRYSTALS
EACH CRYSTAL SUPPLIED with WRITTEN GUARANTEE
"V" Cut: 80-160 Meters within 5 Kc. Specified.
10 Cycle Drift $2.25 — 4 Cycle Drift $3.25
"X" Cut: 160 M. $2.25 — 80 M. $1.95 — 40 M. $2.75
Machined Formica Holders, Gen. GR Plugs $1.00
HAM CRYSTALS
1104 LINCOLN PLACE BROOKLYN, N. Y.

The S-9 Superheterodyne

[*Continued from Page 69*]

The three makes of 6K7 tubes, exchanged *in the i.f. system,* produced no more change than did the use of another tube of the same make. The Triad metal-glass tube is somewhat taller and required a slightly lengthened grid lead but no audible effect followed.

Exchanging 6K7 tubes in the r.f. socket showed a similar effect, except that the slightly taller Triad tube's longer gridlead produced a minor tuning change barely audible on the signals used for test.

When exchanges were made in the 6K7 in the beatnote oscillator socket the usual small frequency shift took place, but it was controlled readily from the panel.

Exchanges in the triode 6C5 high-frequency (or first) oscillator of course produced some tuning-change. Since it was undesirable to alter the trimmers in such a casual test, the size of the effect was not checked. It seemed minor.

The general impression made by the comparison was that the new tubes are uniform to a very satisfactory degree — and incidentally that the test receiver is not "fussy".

◆

Neon Tuning Rod

An inexpensive, neon filled tuning-rod has been released by the DetectO Laboratories, 1721 N. 21st St., Milwaukee, Wis., for amateur use. It is a very handy gadget around the transmitter for indicating resonance, indicating modulating, and for neurtalizing. The rod has been designed to give satisfactory service for from 4 to 6 years, and is guaranteed for 2 years. DtectO also manufactures a special neon unit for use in home-constructed oscilloscopes of the rotating mirror type. The price is very reasonable.

Clear, Complete, Constructive
Take "Radio"

Sh! . . . Silence!

That's what some members of the family would like to tell you, but out of consideration for your enthusiasm they hold back.

CANNON BALL HEADSETS

You will get clearer reception of all foreign programs and you will not disturb the rest of the family.

Made by America's oldest manufacturer of headsets

Heavy bar magnets, double pole, aluminum cases, D. C. resistances of 2000, 3000 and 5000 ohms. Stard construction, sensitive and faithful in reproduction.

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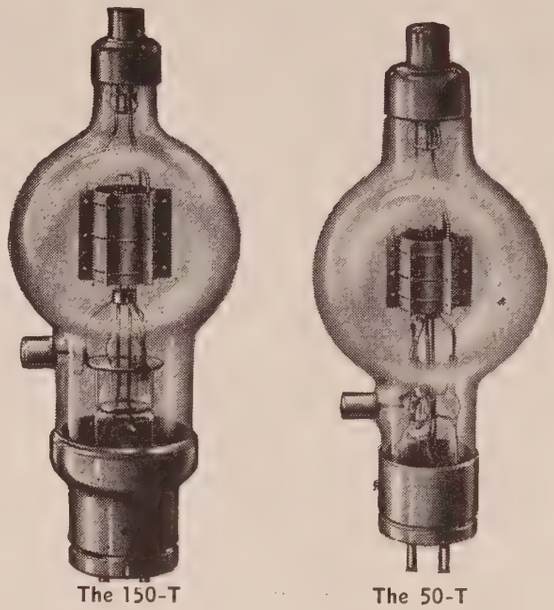

The 150-T The 50-T

EIMAC

TRANSMITTING TUBES ARE THE UNANIMOUS CHOICE OF THOSE WHO WANT THE BEST THAT MONEY CAN BUY

Unexcelled performance, coupled with a ruggedness and ability "to take it" never before found in any vacuum tube, places EIMAC transmitting tubes far above tubes of conventional design.

PERFORMANCE

The ease with which high plate efficiencies can be realized —the low amount of power consumed by the grid when excited for maximum results—the ability to place more watts in the antenna than any other tube operating under similar conditions (EIMAC performance at 1000 volts is just as startling as it is at higher voltages)—the ease with which EIMAC tubes operate even at the highest radio frequencies—the ability to produce enormous amounts of undistorted class "B" audio power—such unusual performance is found only in EIMAC tubes and is made possible by (1) Unique grid and filament design. (2) The use of cylindrical grid and plate which allows symmetrical construction so essential for peak performance. (3) The lowest interelectrode capacities of any tubes of equal power rating or capabilities. (4) The use of a large, rugged, "oversize" filament. (5) The removal of grid and plate voltage limitations. (6) Heavy low loss grid and plate leads. (7) Extremely high interelectrode insulation without the use of undependable internal insulators.

RUGGEDNESS

The paramount thought in EIMAC design is ruggedness. EIMAC design and the use of Tantalum has definitely eliminated such causes of tube failures as gas, stem punctures, insulator breakdown, etc. The large, "oversize," conservatively rated thoriated tungsten filament assures the maximum of tube life and performance.

Be sure your next tube has Tantalum tube life assurance. Tantalum grids and plates permit EIMAC to permanently guarantee against tube failures caused by gas released through accidental overload. Completely degassed Tantalum electrodes make unnecessary and undesirable the use of a chemical agency or "getter" to hold residual gases in chemical suspension on the walls of the glass bulb where any slight overheating would cause a permanent tube failure. No matter what your requirements, remember

EIMAC tubes do a better job—Easier.

Now available in 75-watt, 150-watt, 300-watt, 500-watt plate dissipation ratings at all leading dealers.

Eitel-McCullough Inc.
San Bruno, Calif.

Cable Address: EIMAC.

Armstrong Modulation

[*Continued from Page 67*]

transmitter and the conventional type must be made at different carrier levels for the same tubes. The Armstrong system can work the tubes with a larger carrier-output as there is no intention to modulate upward. For equal bandwidths the Armstrong system is stated to produce about 58% of the noise (same signal) as the amplitude system. Multiplying these factors together with appropriate squaring, an improvement ratio of about 1000/1 emerges, and this is stated to have been confirmed by measurments by the experimental staff and others.

What Is It to Us?

The immediate meaning of the system to broadcasting is that of a problem in reduction to a simpler form. Some of the first superheterodynes sold were 8 feet long and bristled with controls. Until a "simple receiver for simple folks" is available there isn't much percentage in laying down the most magnificently fadeless and staticless signal. This can be done. Major Armstrong says that ignition noises of automobiles very near the receiver do interfere with *weak* signals, but that a 25 kilowatt station would provide reception far superior to anything provided by present high-power stations.

Another problem is that of channel-allocation. The limiter feature produces a curious result. The strongest signal takes control. An interfering signal must be about ½ as strong before more than a whisper breaks through.

To the amateur—"not yet." Major Armstrong does not think there are many people who could *at present* get the system up and make it work. This once was true of the original regenerative receiver. It was also true of the original superheterodyne. The present devices also will get down to simpler terms, and when they are ready for hardy amateurs with lots of faith and patience, this magazine hopes to show constructional data, should a channel then be available for such work.

Special Holiday Gift Offer

Give "Radio"

to two fellow hams at the regular rate of $2.50 per year†

We'll send a third subscription FREE to a third* fellow ham.

Orders must be postmarked *before December 31st.*

*Yes, you may be the third yourself.

Send *Radio* for 1 year to these three hams. Enclosed find remittance in full for two subscriptions. You are to send the third free.

NAME.....CALL.....
ADDRESS.....
CITY.....
NAME.....CALL.....
ADDRESS.....
CITY.....
NAME.....CALL.....
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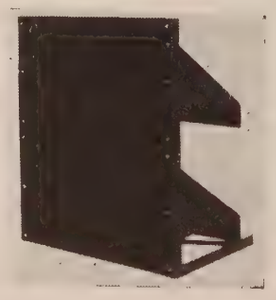
This order sent in by:

NAME.....CALL.....
ADDRESS.....
CITY.....
Code: 145

Able, Accurate, Authoritative Take "Radio"



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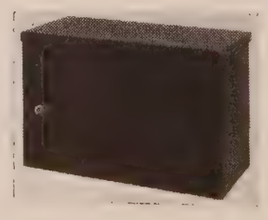


Type "S"

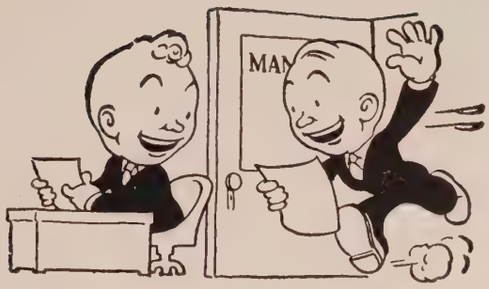
STEEL RACKS AND CABINETS

TYPE 14A RACK—Two 8x14" panels. 8x12½" decks. Black crackle. Plenty strong. $4.25 13 pounds. Postage extra.
TYPE 14B — Same as above but fully enclosed and ventilated. $6.25 19 pounds. With leather handle $6.85.
TYPE "S" STEEL CABINET—7x10x6¼". Hinged lid. Crackle finish. Removable panel and chassis. Completely shielded. $2.20 6 pounds. Postage extra.
See ads in Oct. and Nov. issues. Other sizes and types. We have just what you want or can build it.

R. H. LYNCH

970 Camulos St. Los Angeles

Order direct or see your dealer. In Los Angeles Radio Supply Co.



FLASH!

A.R.R.L. Directors Elected

Just as the last form of this issue goes to press, the results of the A.R.R.L. elections for Director and Alternate Director are announced as given below. For further details and names of the "runners-up" see page 29 of this issue.

ATLANTIC DIVISION:
Director-elect:
Dr. Eugene C. Woodruff, W8CMP
Alternate Director-elect:
Roy C. Corderman, W3ZD

DELTA DIVISION:
Director-elect:
E. Ray Arledge, W5SI

MIDWEST DIVISION:
Director-elect:
Floyd E. Norwine, Jr., W9EFC
Alternate Director-elect:
O. J. Spetter, W9FLG

SOUTHWESTERN DIVISION:
Director-elect:
Charles E. Blalack, W6GG
Alternate Director-elect:
Philip S. Snyder, W6UT

CANADA:
Canadian General Manager-elect:
Alex Reid, VE2BE
Canadian General Managers-reject:
S. B. Trainer, Jr., VE3GT
J. L. Walker, VE3JI
L. W. Mitchell, VE3AZ

RADIO extends its congratulations to the winners, its condolences to the losers.

◆

One authoritative engineering handbook states that ungrounded antennas are successful only on aircraft.

◆

Don't forget to enter the contest. See page 80.

Special Radio Services by Robert S. Kruse, E.E.

—**For the Professional:**
Apparatus and station designs and improvements.
Construction of special apparatus.
Problems involving cathode ray equipment.
—**For the Amateur:**
High-grade discontinued commercial transmitting equipment.
"The Answer Factory," a low-cost information service on operating and constructional problems.
Quotations on request.

ROBERT S. KRUSE
GUILFORD, CONNECTICUT
(Near New Haven)

Real AMATEUR SCOOPS

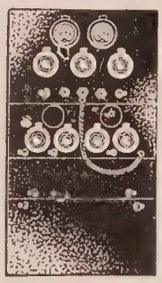
From the New **1936 ALLIED CATALOG**

Between the covers of this catalog, the complete Radio Supply Guide ever published — you will find everything any Amateur may want or need. If you want the newest and finest in Amateur gear, just turn the pages of your 1936 ALLIED Catalog—it's 100% up to the minute. ALLIED is always able to serve you better—and does. We have bigger stocks than ever before—more people to serve you—more live high grade lines—more truly Personal Service for every individual Amateur—more Value than ever before. Here are a few samples:

KNIGHT-JONES "SUPER-GAINER"

Frank Jones designed it. It's hot! A real communication receiver at a price never before matched in Amateur history. Available completely wired, or if you like to "roll your own," available in a kit of matched parts. By the use of regeneration at two frequencies, three tubes do the work of six. Other features are: real Bandspread tuning; iron-core variable coupling I.F. transformers; real selectivity and sensitivity for both C.W. and phone work; regenerative 1st and 2nd detectors; electron-coupled high frequency oscillator, etc. Available in battery or AC-DC models. Send the coupon for Free complete data.

JONES-SILVER TRANSMITTER KITS



Whether you want 25 watts, 50 watts, 150, 250 or 500 r.f. watts, C.W. or phone, the new Silver progressive transmitters designed around the ones harmonic exciter are the berries to build—or to rebuild your present rig up into—for nothing is wasted as power is increased. The illustration shows 500 watts of r.f., with exciter, modulator and power supplies in a 36" rack, yet not a bit crowded. Data is yours for the coupon.

Allied Radio
CORPORATION
833 W. JACKSON BLVD., CHICAGO

Dept. J. 2
☐ Send me your Free 1936 Catalog.
Send me the following:
☐ Free Circular on the Super-Bainer.
☐ Free Circular on Jones-Silver Transmitters.
☐ Enclosed 10c for "How-to-build-it" Book on Jones-Silver X-mitters.

Name.....
Address.....
City.....State.....

Dx Column

We are sorry that RADIO was unable to include Mr. Herbert Becker's "DX" column in this issue. It will be continued as a regular feature, however, starting again next month.

New Square-Case Meters

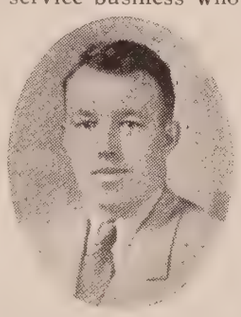
Burton Rogers (manufacturers of Hoyt meters) have released a new line of instruments of the types most generally used in amateur work. Included in the line is a square model with an unusually long scale. The angular design makes an attractive appearance, and although the scale length is 4½ inches in length, the meter is but 4½ inches square at the front. The rear is circular, fitting the standard 2¾ inch diameter mounting hole. The meters are accurate to 2% and are attractively priced, always a big item with the amateur.

WANTED —Fully experienced Radio Service Expert. "Screw driver mechanics" need not apply. Must be fast, accurate and thoroughly familiar with all types of modern radio work. A real opportunity for the right man. State qualifications in detail. Box 101, c/o Bulletin.

Could You Fill This Service Job?

Under improved business conditions, dozens of good-paying opportunities will soon be popping up in radio. Your future depends on whether or not you are qualified to grasp them. Will they go to other fellows—or will you MAKE them come to you!

Sprayberry Training is designed NOT for beginners but for men already in the service business who recognize the need for keeping up-to-date. It is for men who know that, to get better-than-average jobs, they have to be better-than-average workmen. It is sound, practical business and technical training—at a price within the reach of all. Investigate!



LET ME HELP YOU BUILD FOR REAL SUCCESS IN SERVICING

F. L. Sprayberry, 2548 University Pl., N. W., Washington, D. C.

Without obligation, send me details on your advanced Service training.

Name.....

Street.....

City..... R1/36

SPRAYBERRY'S PRACTICAL MECHANICS OF RADIO SERVICE

COMPONENTS OF LABORATORY MODELS

For the convenience of those who may wish to reproduce closely the mechanical form as well as the electrical performance of some of the apparatus described in this issue, we list below some of the commercially manufactured parts which happened to be used by the author or by our laboratory in the course of construction.

It should be pointed out, however, that other parts of equal merit and of equivalent electrical constants may usually be substituted without materially affecting the performance of the unit.

Dawley 500 Watt Amplifier

Dials—Crowe
Rack—Lynch
Meters—Triplett 3½ in.
C_1—Cardwell type MT 70GD
C_3—Sangamo 5000 v. mica
C_4—National t pe NC-800 neutralizing
C_5—Cardwell t pe 312B
RFC_1—National type R-100
RFC_2—Hammarlund type CH-500
Tubes—Eimac 50-T

Harwood Condenser Mike Preamplifier

Head—Haas Standard
C—Girard-Hopkins ½ µfd. paper
C_1,C_2—Aerovox type 1450
C_3—Cornell "Cub" Cartridge
C_4—Cornell type FD "Hi-Mike" Cartridge
R,R_1,R_2,R_3,R_4—S. S. White
R_5—Centralab ½ watt
R_6—Ohmite 3 watt carbon

Brown 210 Transmitter

C_4—Carwell transmitting Trim-Air 30µµfd.
C_6—Cardwell t pe MT 70GD
C_7—Cardwell type XT 210PD
Coil forms—Hammarlund type XP53

Gordon 801 Transmitter

Rack—Radio Engineering Products
Coil forms—Hammarlund type XP53
RFC—National type R-100
C—Sangamo 1000 v. mica
C_1—Hammarlund type APC
C_2— " " MC-35S
C_3— " " APC
C_4— " " MC-20-SX
C_5— " " MCD-35-SX
C_6— " " TCD-100-X
C_7— " " MC-20-SX
R_1,R_2,R_3,R_4,R_5,R_6,R_7—Ohmite "Red Devil" 10 watt
R_8—Ohmite "Red Devil" 10 watt center tap

EXPIRING!

★ **We regret that rising costs force us to announce that the special rate of $2.00 for a year of RADIO and one copy of THE "RADIO" HANDBOOK offered in the December issue of RADIO and the October issue of THE SHORTWAVE DIGEST EXPIRE on December 15, 1935, and orders postmarked after that date will not be honored.**

The same offer, subject to cancellation without notice, will be available throughout January, 1936, at a price of $2.50 in U. S. A.; $2.65 in Canada, Spain, Newfoundland, and independent American countries; and $3.40 elsewhere.

RADIO, Ltd.

7460 Beverly Blvd. Los Angeles

Lifesaving Construction

By E. H. Conklin, W9FM

Most of us become so used to working on our transmitters that we are sometimes inclined to forget for the moment just how deadly a high voltage power supply may be. A carelessly-driven auto may be "Sudden Death," but 1500 volts is twice as quick! Just as in driving a car, a little caution, judiciously exercised, pays big dividends.

During the past fifteen years, we have had several experiences in the matter of getting across the high voltage supply of various transmitters — the latest resulting in a vaccination mark that has nothing to do with the smallpox. Pressing the key, leaning over to peek around the rack and bumping against the plate milliammeter were the causes. Several cases of getting tangled with 1500 volts or more included one of tuning a "200 meter" transmitter back in 1922, and "accidentally" trying to move a clip on the inductance and push the key at the same time with the other hand. Figuring one foot for each 100 volts, most of it must have been *up,* for we landed behind the chair without upsetting it!

For years, reports have reached us of accidental deaths from power supplies. From the outfits most of us use, it is a wonder that the death rate is so low. But there are many precautions which can, and should, be taken. Perhaps you know of others, but here are some:

Primary keying is a great help. It largely eliminates fooling with the transmitter when the power is on, because when the set is not radiating there is no high voltage.

It is customary to ground the negative high voltage to the ground or shielding. This is *very* dangerous. We once touched the positive end of 2300 volts, rectified, and at the same time bumped against a radiator. Because the negative was not grounded, we live to tell the tale. If it is necessary to ground a transmitter, such as when using a single wire feed antenna, do it through a good, high voltage condenser, shunted by a 1 or 2 *megohm* resistor. Grounding the shielding is satisfactory just so neither ground nor shielding is connected to the negative, except perhaps through the high voltage condenser. Don't hook low voltage supplies and circuits to high voltage ones—it is usually not necessary with link coupling, and at other times it can be done through a high voltage condenser. Don't connect the negative to more metal than is absolutely necessary—that just increases the dangerous area and likewise the possibility of getting hold of both the negative and positive.

If tubes of the 852 type are used, string cheap glass beads on the wire plate lead to make it nearly impossible to touch. Put the stopping condenser close to the plate lead, and wrap several layers of good rubber insulating tape over the bare binding post. Give the plate r.f. chokes the same treatment. Use an insulating bevel over the front of the plate milliammeter (if in the positive lead) and tape up the binding posts in the rear. If the plate lead goes to a tube socket, cover the terminal somehow. The power supply can receive the same treatment, but if not possible, enclose the unit in such a way that opening a cover or door automatically breaks the primary voltage. In short, build the rig so that neither the plus nor the minus high voltage can be touched even accidentally. It should be absolutely impossible to get both ends of the power supply at the same time. Once we pushed a hand in the W9MZ transmitter with the high voltage generator running, something touched something, and we had to count our fingers by feeling with the other hand to find how many were left. When our sight recovered from the flash, we saw that one finger had been between things, and the bone was laid bare.

If your keying system involves connecting the key to the high voltage, such as with bias or center tap keying, use a relay insulated between armature and coils well enough to stand the full voltage; and don't use the filament voltage to operate the relay—use a separate transformer winding.

We learned long ago to keep one hand in a pocket, and never to stand on anything but insulation—or to kneel on a chair—when touching the transmitter, on or off. Perhaps that is why it has been 13 years since we took the high voltage through the heart. A few thousand volts between the fingers or down one arm may only burn off a bit of flesh; the same voltage between two arms or from hand to leg may very well be fatal.

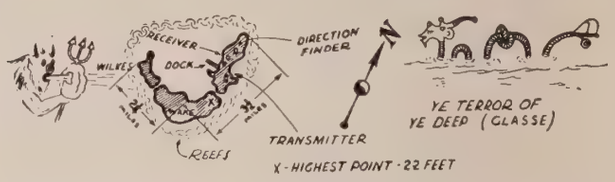
W6TE AT WAKE

1935, (I guess)

Dear om's:

I didn't quite get to China this time because they [Pan American Airways] needed a good man here at Wake, hi! Anyhow, I am to be stationed here on this place for six months or a year. By that time I am to be transferred to some other point—in a box or straight-jacket. However, it isn't at all bad here, not as bad as I expected anyway. The reference books give the impression that Wake Islands are sort of small but they are quite large, all of three square miles. The group comprises three islands namely Wilkes, Wake, and Peale. Peale Island, being the largest, harbors the settlement and all the equipment of the present expedition. To the left one may see the vast lagoon in which are many and various fish of all description. To the right one may see the vast reef that catchs the fish of many and various descriptions. Gosh, sounds like a travel-book.

But, all kidding to one side, this place is a swell little jernt. The islands form a "U" shaped group, and the result is a perfect lagoon. A series of reefs encircle the group and keep out all large sharks and other huge fish that abound hereabouts. The place is laid out sumpin' lak' dis:



This certainly is some experience, and I'm glad I got out of my old job when I did, as I was apparently headed for a bad rut. Here, at least, I have some chance to make an advancement. Anyway, we are getting plenty of experience at installation work as we have installed three stations so far, completely remote controlled. They are the new Western Electric 14-A transmitters that can be used on ten different frequencies by merely channelling a standard telephone selector dial. Some layout, after the bugs are worked out! This installation here at Wake is surely putting out. Our frequencies range from 16,440 kc. to 1638 kc. at present; more may be added later.

The direction finder system is the precision job of the whole scheme and is certainly "the berries". It works on the gonimeter principle, but the airplane gives the signal and we give him the line of departure. From that the navigator figures his position by dead reckoning, and it is two to three thousand miles. All the equipment was rebuilt especially for this service in Pan American shops and is practically foolproof—(hope so). It took us three weeks to put up this station; I had charge of the receiving position and remote control equipment. It's great fun working with other people's tools and equipment and building up one's own ideas. I have lots of good ideas for a ham station now, hi!

The construction crew left with the *North Haven* a couple of weeks ago. Now we have only sixteen men here including six Chinese servants. They come in handy, hi. The weather has been delightful almost all the time we have been here, like a blustery spring day in Southern California—a clear sky with a cool wind but quite a tingle to it that makes it sort of exciting even to walk along the beach. I'll never regret having come on this job; sort of sets one at ease and gives him a better perspective on everything in general. Maybe, I'm slowing up, going native, or something, but it's a great feeling to be alive out here. Boy, am I getting to be the idealist; I'll be writing poetry before long.

The only time to write that I seem to find is when I'm on watch. They start slow as the devil. Nothing to do for a couple of hours; I get well into

[*Continued on Page 99*]

Get the most out of Your Other Equipment by using

Brush Type-A 'Phones

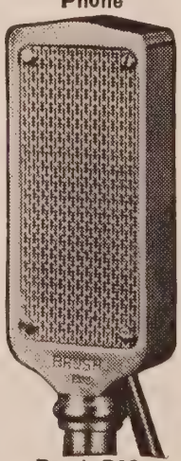
and

Brush Mikes

are ideal for amateur transmission. Greater volume is secured from weak signals. Response 60 to 10,000 cycles. Brush 'phones handle excessive volume without overloading—have no magnets to cause diaphragm chatter. Newly designed cases minimize breakage. Weight, only 6 oz. Now available at the new low price—only $9.00 list.

Brush Type-A Phone

B2S mikes are ideal companions to Type A 'phones. No distortion from close speaking. Operate directly into high gain amplifier. No input transformers. Not affected by severe changes in temperature — rugged construction. Fully guaranteed. Weight 3 oz. Overall height 4¼ inches. Price, only $45.00 list.


Brush B2S Microphone

Full details and typical circuit diagrams free on request. Write for copies.

The BRUSH DEVELOPMENT COMPANY
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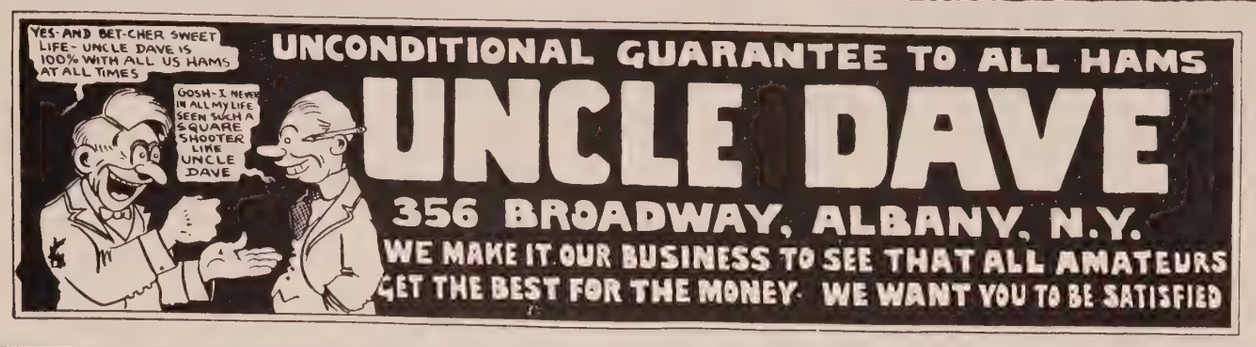
1886 E. 40th St. CLEVELAND, O.

MICROPHONES • MIKE STANDS • TWEETERS • HEAD PHONES • LOUD SPEAKERS


YES-AND BET-CHER SWEET LIFE- UNCLE DAVE IS 100% WITH ALL US HAMS AT ALL TIMES
GOSH-I NEVER IN ALL MY LIFE SEEN SUCH A SQUARE SHOOTER LIKE UNCLE DAVE
UNCONDITIONAL GUARANTEE TO ALL HAMS
UNCLE DAVE
356 BROADWAY, ALBANY, N.Y.
WE MAKE IT OUR BUSINESS TO SEE THAT ALL AMATEURS GET THE BEST FOR THE MONEY- WE WANT YOU TO BE SATISFIED

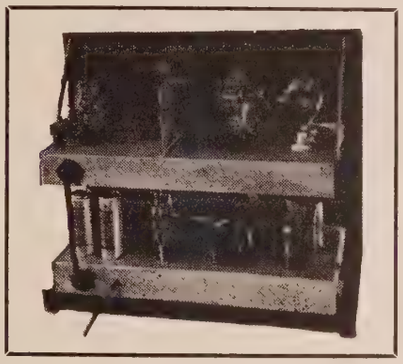
METERS

Weston 301 milliammeters, 0-5, 10, 15, 25, 50, 100, 200, 250, 300, 500 ma, each.....$ 2.95
Above ranges, bakelite cased, each..... 3.65
0-150 volt AC voltmeters, each..... 5.25
Weston 440 galvanometers..... 20.00
Weston 440 micro ammeters 0-15..... 20.00
Rawson & Sensitive Research microammeters, similar to above 440 0-15 microamperes, directly calibrated, **SPECIAL**..... 12.50

SPECIALS

Oil condensers, new compact type 2 mfd 2000 volt....$2 75
3 mfd 1000 volt..... 1.95
New improved Mac Key, special..... 7.95
Thordarson filament transformer; 7½ v. 3 a; 2½ v. 5 a; 1½ v. 4 a, our net..... .95
Thordarson 30 hy, 125 ma chokes..... .95
Thordarson 20 hy, 175 ma chokes..... 1.25
3" black pointer knobs, complete with celluloid dial plates, per set..... .35
4" dials, large knob..... .10

PEERLESS "40 DX" TRANSMITTER . . . A crystal controlled transmitter for Phone or C.W. operation. Tube complement: 2A5 oscillator, 2-46's power amplifier, 83 rectifier, 56 speech amplifier. The west coast is worked on 80 meters with this job on C.W. from Albany and often distances up to 1,000 miles are worked on the same band on phone. Here are a few of its features in concise form.



***Standard Rack mounted
***35 to 40 watts output on C.W.
***10 watts output on phone
***Crystal ground to your specified frequency
***Full output on 2 bands with 1 crystal
***2A5 Dow or Tritet oscillator

This transmitter comes complete with "ALL" accessories, including crystal, coils for 2 bands, tubes, microphone, and in fact, everything but key and antenna.

Transmitter for combination Phone CW.....**$63.50**
Transmitter for CW only..... **52.00**
PEERLESS "40-DX" R. F. PORTION, complete with coils for 1 band and crystal holder, less tubes, crystal, power supply and rack net, special.....$17.50

TUBES

Latest type 866's, RCA.....$ 2.25
RCA-803 ..... 38.50
RCA-838 ..... 18.00
RCA, slightly used 852..... 8.95
RCA, slightly used 851..... 47.50
Raytheon RK-10..... 3.50
RCA-801 ..... 4.50
RCA-802 ..... 3.90

PEERLESS 3-tube Professional AC receiver, wired and tested, with tubes, power supply and 2 sets of coils for 15 to 200 meters, net specials.....$15.75

Broadcast coils, set of 4 for above.....$ 2.00

PEERLESS 2-tube LOUDSPEAKER AC receiver, wired and tested, with tubes, power supply, and set of coils for 15 to 200 meters, net special.....$12.75

PEERLESS CRYSTALS

160 and 80 meter crystal with special ceramic holder $3 25
40 meter crystals, completely mounted..... 3.95
A cut crystal, complete with special holder..... 5.00
Crystal Oven, complete with crystal ground to your specified frequency, crystal holder, thermometer, thermostat, net..... 8.25

NEW Super Skyrider, Model S-9, complete with nine tested Raytheon tubes, iron core I.F., five bands, automatic volume control, your net.....$79.50

NEW Hallicrafters "Super-Seven," complete with seven test Raytheon tubes, three bands, your net.. 49.50

National HRO, complete with tubes and coils, less power supply and speaker..... 167 70

HRO National type 5897 AB power pack..... 15.90

National HRO speaker in cabinet..... 13.80

Baldwin headphones.....$2.50

5" 3000 ohm dynamic speakers pentode output xformer.... 1.95

R. E. L. 80 meter inductances..... 1.25

R. C. A. handmikes..... 1.95

3" airplane dials and escutcheon..... .95

Rider's Cathode Ray Books..... 2 50

Faraday 12 v. AC Buzzer..... .59

ROLA high fidelity 12" type G-12 speakers, field resistence 1000 and 2500 ohms, less output transformer....$9.95

Cable Address "Uncledave"

Include 20% Deposit with C.O.D. Orders

LONG DISTANCE PHONE 4-5746

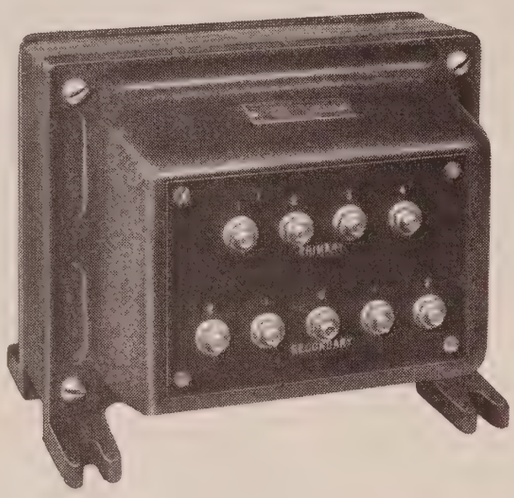
UNCLE DAVE'S RADIO SHACK 356 BROADWAY ALBANY NEW YORK.

Send to Dept. R-6 for our New Ham Catalog—Just off the Press! Foreign Trade Solicited.

Prices F. O. B. Albany

INCA
Transformers

FOR THE HI-POWER FAN



Hams using HK 354's or 150-T's and wishing to get a kilowatt input without mortgaging the old homestead will be interested in the INCA numbers listed below. These husky, well-insulated transformers and chokes are designed for exceptional hi-power service.

INCA B-37—will supply 2000 or 3000 volts D.C. at 500 M.A. through a choke input filter, primary for 115 or 230 volts—heavy case—exceptional impregnation—porcelain terminals.

List Price - - - - $49.75

INCA J-33—Filament transformer for two HK 354's or 150-T's — Skeleton Mounting — 3500 volts insulation—deliver 5 volts at 20 amperes — Primary 105-110-115-120 volts.

List Price - - - - $5.40

INCA D-45 — and D-32 — Respectively — 60/12 henries and 20 henries — Swinging and smoothing choke for 500 M.A. circuits. Heavy cast case—Porcelain terminals—10,000 volts insulation.

List Price — D-45 $14.00
List Price — D-32 $15.00

All the above, and many more quality transformers, are described in INCA BULLETIN No. L-11, obtainable from your jobber or from:

PHELPS DODGE COPPER PRODUCTS CORPORATION
INCA MANUFACTURING DIVISION
2375 East 27th St., Los Angeles, Calif.

"Radio" Contributions

[*Continued from Page 72*]

Size

Better a good small picture, taken from the proper distance, than an oversized affair of 3d grade. Please don't worry about filling up the film. Naturally we prefer to have prints from 4" x 5" or larger films since there is then a chance to retouch—but a *good* 2¼" x 3¼" may not need retouching.

Antenna Photos

No good antenna photo was ever taken. Therefore ignore the wires and get a picture of the poles. Use a "ray filter." To the back of the finished print paste a sheet of "onion skin" paper and fold it down over the photo. Then with a fine pencil sketch the antenna on this paper as carefully as you possibly can, not forgetting to show insulators in proper shape and size. Plenty of notes on an attached paper will help the retoucher to paint in the antenna.

Inside the Shack

The radio shack is always crowded and not properly lighted. It is hard to get the clutter out of the background, but we would rather have all the junk in creation showing than a streaky white background. White paper or sheets are *bad*. Use a gray blanket if possible and move during exposure if you can. In a pinch use gray or brown paper, but don't join sheets with paste or mucilage. Use rubber (tire) cement and let dry for 15 minutes, then handle gently. Getting enough distance is a harder job. It has been done by working through a window; in one case even by working around a corner with the aid of a high-grade plate glass mirror from a dresser in the "company" bedroom, doubling the exposure to make up for absorption and praying the family didn't get back before it was over.

"Deep" Apparatus

When the thing to be shown measures more than a few inches fore and aft, it is extremely important to *keep the camera away* as far as possible. For instance, in taking a tableful of equipment we find that the table is 30 inches wide front to back. We try to get the camera at least 9 feet away (let the picture size take care of itself) and focus on a bit of printed paper set 1/3 of the way back. If the camera (as usual) has to be focussed by a little scale on the camera we measure 9 feet from the table, put the lens there, and set for 10 feet—and *don't* forget to stop away down.

TRADE IN YOUR RECEIVER

- HAMMARLUNDS-NATIONALS-RME 9D.
- McMURDO-SILVER-PATTERSON. ETC.,

RECEIVERS SHIPPED PREPAID-NO EXTRA CHARGE TO WEST COAST.

SCHWARZ RADIO SERVICE
15 LAWRENCE AVE., DUMONT, N.J.

Summary

Even lighting.

Very small stop, never larger than f16 or US 16, and better f32 or 64—128 if possible.

Very long exposure, 4 to 30 seconds by outdoor daylight; 1 to 29 minutes indoors (by photo*flood* lighting).

And, of course, keep a "log" so it will turn out better next time.

◆

LISTENER'S UTOPIA

Australia has two broadcasting systems from which listeners may select programs. One handles commercially-sponsored broadcasts; the other is government owned and operated. The commercial system has fifty-three stations, each limited in power to one kilowatt. The noncommercial, or Class A, stations number twelve and have unlimited power. The listener pays an annual license fee of £1 sterling and takes his choice of broadcasts.

Australians are believed to be one group in the world that misses the opportunity to complain about the limitations of its radio system, because it has both. For example, Americans have the commercial system and are frequently heard to wish they had the noncommercial such as prevails in England. And, according to reports from England, the Britisher wonders once in a while if the sponsored-program idea would not be more entertaining.

The Australian, however, has but to turn the dial and eaves-drop on what he prefers. He seems to enjoy a sort of listener's Utopia. There are about 800,000 set-owners in Australia today.

—*New York Times.*

[We await with interest the comments of RADIO's Australian readers.—EDITOR]

◆

Charlie Myers, W3SI, is looking for a station in Zone 23. That is all he needs for WAZ!

◆

Seriously we wonder how many hams do receive new QSL's to replace the home-made ones sent out when supplies are exhausted. The new ones are always promised.

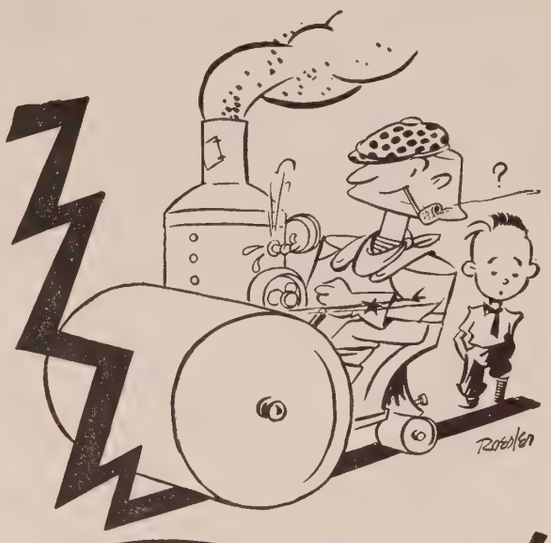
◆

A recent alarming headline—TUBE COSTS SET AT $19,600,000. As we read further along, it was disclosed that the *tube* was the Boston traffic tunnel.

◆

Accumulator as the early monicker for storage battery. . . . *Jigger* as same for coupler. . . . *Rheometer* for galvanometer. . . . A potentiometer is *not* a potentiometer—a *voltmeter* is. . . . *Litzendraht* wire is now just plain Litz.

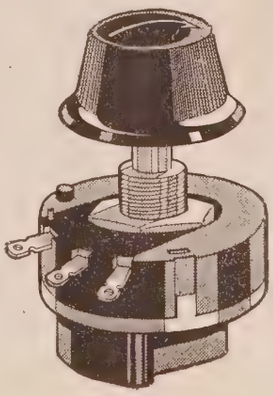
The Worldwide Authority
Take "Radio"



"Smooth job - eh?"

Old Man CENTRALAB is at the wheel my fraand! Arch-enemy of noise . . . as smooth as an ambassador . . . he takes those noisy "sets" and pretso: the customer pays with a smile. Thousands (yes thousands) of servicemen everywhere carry a small stock of CENTRALABS at all times . . . and they can service practically any job . . better than ever before.

Centralab smoothness results from the patented Centralab non-rubbing contact whereby a strip of polished metal rocks on the resistor so that the only rubbing action is between an oilless wood bearing and the polished metal.



Centralab

CRL

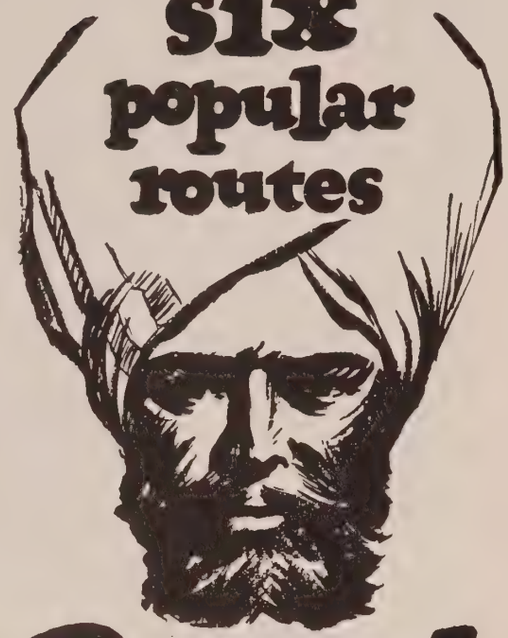
Milwaukee, Wis.

RADIOHMS SUPPRESSORS

FIXED RESISTORS

Your choice of

six popular routes



Round the World

"ALL EXPENSE" TOURS ALSO AVAILABLE

◆ CRUISE around the world on a tour of your own planning—a cruise personally conducted by no one but yourself. Go where you please, stay in any land that suits your fancy. And your ticket is good for two years. Roam the seven seas — on either side of the equator. New thrills await you . . . the mysteries of Asia . . . enchanting Bali . . . the spell of India . . . the drums of Africa . . . the Holy Land . . . Europe, New Zealand, Australia. Where do you want to go? Come in and discuss your plans with us. Over 200 itineraries from which to choose. Special round the world service.

Send for Descriptive Booklet

Information regarding the various routes, fares and sailings are included in our new booklet, "Independent Round the World Tours". Ask your local agent or the Canadian Pacific: New York, Chicago, Los Angeles, San Francisco, Montreal and 32 other cities in the U.S. and Canada.

Canadian Pacific

WORLD'S GREATEST TRAVEL SYSTEM

Simple 74 Ft. Tower

[*Continued from Page 48*]

guides to keep the tower from swinging sidewise on the way up.

A 90 foot tower was made of the same construction merely by extending the upright runners and going on up with the sway-braces and girders. After much heated debate and gnashing of teeth as to whether or not it would be self-supporting if anchored strongly enough at the base, the author was finally out-argued because of the superior number of the guy-wire exponents, and instead of a W6DDS concrete foundation several sets of guys were used. However, with a dozen power leeches (guy wires) tied onto a tower it is doubtful as to whether or not it allows as efficient a radiating system as a shorter tower with no guy wires.

Don't forget to tar the rope used for the antenna halyard; it will last three times as long. It is a simple matter to climb up as far as the girders go should the rope break and slip through the pully, but shinnying up the 4 x 4 for the last 14 feet is kind of tricky business and not exactly conducive to longevity.

◆

With the Editor

[*Continued from Page 9*]

which has frequently been thrown overboard in late years—and each time we've lost another piece of our pants. If only our people could be made to realize that the International Telecommunications Convention is just a little League of Nations, with its scope confined to telecommunications. The whole world knows what we think of that sort of foreign domination.

Let our representatives as the spokesman of a free people with inalienable rights announce to the world that our amateurs are entitled to the use of more frequencies by reason of the proportion of their numbers to those of other services, by reason of their rights as citizens, and by reason of the public services which they render, and that the government of this country intends to see to it that justice is done, that it will ratify no allocation schedule which does not more adequately provide for its amateurs. The time has come when we must inform the world as bluntly as may be necessary that we are entitled to the use of our own ether and intend so to use it. Let us brook no more foreign interference in radio or other affairs.

◆

Blow the dust off your mill and load your camera. See page 80.

K6TE at Wake

[*Continued from Page 94*]

a letter, and all hell breaks loose from both sides. This line isn't as busy as the old one back on the mainland, but it will be a fast line as soon as the clipper ships start to fly regularly with passengers and so forth. Quite a jump when one thinks of it. Here on the spot one is apt to overlook the romance of the whole thing (more perspective stuff, hi) and lose sight of the glamor a la newspapers and such. Must QRT now or get my neck burnt. Hasta la vista, amigos.

BILL BREUER*

◆

A radio transmission made from the Atlantic coast at one o'clock in the morning is picked up on the Pacific coast the day before.

◆

The modern symbol for resistance, the familiar zigzag line, is identical with the ancient Egyptian hieroglyphic character for water.

◆

C. Francis Jenkins, television pioneer, invented a motor which runs *directly* on static electricity drawn from a receiving antenna.

◆

A religious writer has predicted that the rural church of the future will be equipped with a radio instead of an organ.

*K6TE, Wake Islands; formerly W6TE of Los Angeles, widely known as the "Big Noise of the West".

Let's Get Together

Your inquiry about any apparatus will prove to you that it is to your advantage to buy from me.

I give you specialized personal service of genuine value that is not available from other jobbers.

I take in trade apparatus you do not need on apparatus you do need. So I have used apparatus at big savings too.

I stock at lowest prices all amateur apparatus.

GOOD NEWS: All PR-16 models in stock for prompt delivery shipped prepaid. All receivers shipped on ten day trial. You need send only **$5.00** with order.

IN STOCK — IMMEDIATE DELIVERY

The New **RME-69s**	**$118.80**
PR-16s (at last) prepaid	**95.70**
National HROs	**167.70**
Breting 12s complete prepaid	**93.00**
Silver 5Ds complete prepaid	**109.80**
Super-Sevens complete prepaid	**49.50**
The new **Super Skyriders** complete prepaid	**79.50**
RCA ACR-136s complete	**69.50**
Super Pros complete	**194.04**
Collins and **RCA** transmitters	

TRADE IN YOUR RECEIVER OR TRANSMITTER

Every inquiry and order is personally attended to by Robert Henry, W9ARA; an active amateur for eleven years; graduate E.E. from M. I. T.; and owner of Henry Radio Shop selling amateur apparatus for seven years. Write for any information.

◆

HENRY RADIO SHOP

211-215 North Main St. **Butler, Missouri**

THE DECKER COIL AND LINK

A LOW-LOSS WIRE COIL THAT TAKES A KILOWATT AND LIKES IT!

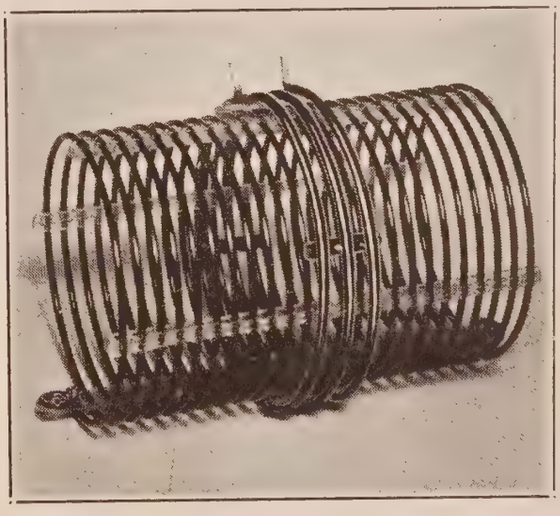
Band	Coil	Series "A"	Series "B"
160	Final	$4.15	$6.25
	Buffer	3.30	5.00
80	Final	3.30	5.00
	Buffer	2.90	4.40
40	Final	2.90	4.40
	Buffer	2.50	4.00
20	Final	2.50	3.75
	Buffer	2.20	3.50
10	Final	2.10	3.00
	Buffer	2.00	2.75
All Bands	Link	.90	2.50

Above prices are list
40% discount extended licensed amateurs

When ordering be sure to state capacity with which you intend to tune. Also if possible diagram circuit in which used.

DECKER MFG. CO.

SOUTH PASADENA, CALIF.



The final important improvement in air wound wire coils has been achieved. The unavoidable mechanical weakness of copper wire has been overcome.

The new series "B" Decker Coil is made of a special high carbon steel-core wire. The Series "B" not only *"Takes a kilowatt and likes it"*, but also smiles at mechanical abuse.

The electrical efficiency remains the same and the strength is increased enormously by the steel core.

We continue to supply the Series "A", coil as before. The net price remains the same.

If your dealer cannot supply you order direct.

AN EXPLANATION AND APOLOGY TO OUR READERS AND ADVERTISERS

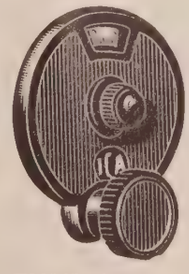
The "R/9"—"Radio" merger, when it did occur, happened suddenly, as such things do. After deliberation, it was decided to adhere to the former "R/9" publication schedule which was considerably in advance of the former "Radio" publication schedule.

This advance in publication and closing date has made it physically impossible for many regular "Radio" advertisers to be represented in this issue. We present our apologies to all concerned, and hope that the next issue will be in ship shape order.

QUALITY VERNIER DIALS

TYPE 2211 is a three window, four inch friction drive bakelite mouded dial. Beautifully egg-shell, black finished, this dial enhances every job used on. Clockwise rotation of 0-100 through 180 degree. Ratio 9 to 1. . . . . List **$1.75**

TYPE 2210 is a 2¼" direct drive egg-shell, black bakelite dial. Easily illuminated, if desired, it rotates clockwise 0-100 through 180 degrees. For ¼" shaft. . . . . List **$. 75**



TYPE 2213—three inch single window egg-shell, black bakelite dial, 0-100 clockwise rotation through 180 degrees. 7 to 1 ratio vernier drive. . . . . List **$1.50**

TYPE 2212—similar to 2211 minus two windows and is finished in smart antique. 9 to 1 ratio for ¼" shaft. . . . . List **$1.50**

Available at all ICA distributors. For complete catalog send 10c in postage or coins to cover cost of handling and mailing.

INSULINE
CORP. OF AMERICA
25 PARK PLACE • NEW YORK • N Y

Raytheon Type 0Z4 Rectifier

A new rectifier tube, type 0Z4 has been developed by Raytheon Engineers especially for automobile radio supply systems.

This new Raytheon Tube has no filament but operates through the ionization of a gas contained in the glass inner bulb. In basic principles the 0Z4 is closely related to the gas rectifier which Raytheon pioneered in 1922.

The 0Z4 was developed primarily for use in vibrator type B-supply units for automobile receivers. It has the typical characteristics of all gas-filled rectifiers as regards a constant drop and ability to handle peak currents and a tendency to generate r.f. noise. The r.f. noise may be eliminated by proper filtering and by connecting the metal shell to the point giving the best shielding. The shielding and filtering commonly used to eliminate vibrator noise will usually be sufficient.

The 0Z4 has the same external form and dimensions as other tubes of the metal line. However, in this tube the metal shell serves chiefly as container and electrostatic shield for the glass bulb, which is required to insulate the contained gas from the grounded shell.

The 0Z4 is rugged and has no filament to break or burn out. It is expected to simplify the power supply problem for many automobile receiver manufacturers during the coming season. The base of this tube is a standard octal type. The list price of the 0Z4 is $1.75. It will deliver 300 volts d.c. at 75 ma. (maximum rating).

◆

It is rumored that Andy of the famed Amos-Andy radio team has been bitten by the ham radio bug and is hard at work learning the old dots and dashes.

◆

Don't forget to enter the contest. See page 80.

Be Thrifty — Save a Dollar
"Radio", 1 yr., $2.50 "Radio", 2 yrs. $4.00
U.S.A., Canada, Spain, Newfoundland, and all independent American countries.

7000 Kc XTALS

New thick C&S cut high activity, single freq. response, guaranteed close to specified frequency. **$2.25** p.p.

80M - 160M - C&S Cut - $2.00 p.p.

C&S XTALS
836 E. WEBER AVE. STOCKTON, CALIF.

500 Watt Amplifier

[*Continued from Page 59*]

coils inductively coupled to each end of the plate tank and also to avoid tapping a 500 ohm line directly on the tank. Both types of line usually have some standing waves on them and even the π type of network often introduces some reactance back into the tank circuit. The presence of this reactance will make the stage difficult to neutralize and will often so reduce the plate efficiency as to cause the final amplifier tubes to run quite hot.

When properly adjusted there should be an equal amount of "fire" at each end of the plate tank coil when tested with the well known pencil test.

◆

During a tornado-flood disaster, the telephone company in W9LJF's town put a special operator on his line to handle the deluge of traffic calls to his shack.

◆

An English experimenter once claimed the discovery that selectivity is increased remarkably by immersing the antenna coil of a receiver in liquid air.

◆

The problem of low-resistance bias supply does not worry W6RO. He has over 200 volts of 200 amp. hr. storage batteries that he uses for bias!

◆

George Simon Ohm, whose own name was to be immortalized by the unit of resistance, named the galvanomter in honor of Lugi Galvani.

◆

It may mean $75 to you. See page 80.

GOING ★ BIG!

ANOTHER BOOK BY "RADIO"!

• Frank C. Jones' new 68 page book . . . **The Radio Amateur Newcomer** . . . 25c per copy. Another "best seller". Tells how to build three excellent receivers, three transmitters, a very good Frequency-Meter-Monitor, and one of the most practical 5-meter transceivers. Many fine illustrations and circuit diagrams. Contains the very latest F.C.C. Amateur Laws and Regulations, Standard Frequency Schedules, code practice instruction, etc., etc. Unquestionably the most complete and finest work for the newcomer in amateur radio.

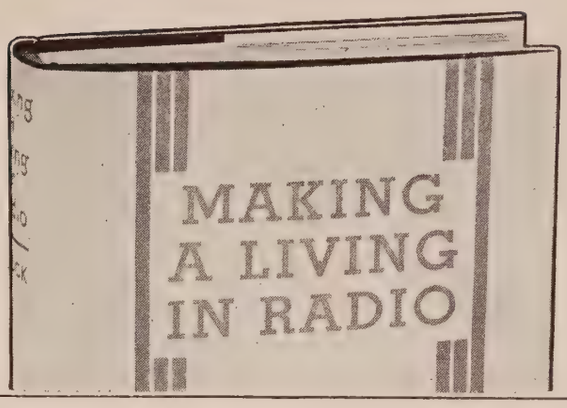
Order your copy at 25c postpaid from

RADIO, Ltd.

7460 Beverly Blvd. Los Angeles, Calif.

Dealers and Jobbers supplied by Pacific Radio Publishing Co., Pacific Bldg., San Francisco

Just Published



This book tells you what you need to know before taking up some field of radio as your life work.

MAKING A LIVING IN RADIO

by ZEH BOUCK

Contributing Editor, "Radio News"

NOW you can learn just what opportunity there is for anyone with a real interest in radio as a vocation. **What jobs are there? How much do they pay? How should you train for them? How can you break into the game, and then get ahead?** This book tells you. It covers not only technical jobs in radio, but also the fields of writing, broadcasting, salesmanship, etc.

Here at last is factual information on the whole field of radio of the kind you have wanted. Without painting exaggerated pictures, the book tells frankly what the field offers, what you need in order to know whether you want to go in for radio servicing, broadcasting, operating, engineering, or any other branch, and how to go about it.

Are You Interested In.....?

—how to determine whether or not radio is really your vocation
—how to choose a school
—what books to buy
—how the operator can get a berth
—a lucrative by-product profession for the operator
—business expansion and engineering careers for the serviceman
—self-training in radio writing
—opportunities in radio engineering
—breaking into broadcasting

Then see this new book. Interesting up-to-date, sound and authoritative. 220 pages, illustrated, $2.00. Sent for 10 days' examination on approval. Just mail the coupon, today.

McGRAW-HILL ON-APPROVAL COUPON

McGraw-Hill Book Company, Inc.,
330 W. 42nd St., New York, N. Y.

Send me Bouck's Making a Living in Radio for 10 days' examination on approval. In 10 days I will send $2.00, plus few cents postage, or return book postpaid. (Postage paid on orders accompanied by remittance.)

Name.....

Address.....

City and State.....

Position.....

Company.....R/9 1-36

(Books sent on approval in U.S. and Canada only.)

DIRECTORY OF DEALERS

A List of Dependable Amateur Supply Houses

On request, rates for advertising in this section will be quoted established dealers of known reliability.

CHICAGO, ILLINOIS

Chicago Radio Apparatus Company, Inc.
415 South Dearborn Street
Harrison 2276
Dependable Radio Equipment
Established 1921
Bulletins on request.
Everything for the amateur.
Get our very low prices.

HAWAII, HONOLULU

Honolulu Furniture Company, Ltd.
Cor. Beretania & Emma Sts.

SAN FRANCISCO, CALIFORNIA

OFFENBACH ELECTRIC COMPANY
1452 Market Street
"The House of a Million Radio Parts"
Hammarlund and National sets and parts.
RCA and EIMAC Tubes.
Arcturus Receiving Tubes.
Trimm Phones, all types.
Johnson Antenna Feeders, Insulators,
Transposition Blocks.

FRESNO, CALIFORNIA

PORTS MANUFACTURING CO.
3265 E. Belmont Ave. Radio W6AVV
National FB7-SW3 and Parts; Hammarlund, Cardwell, Bliley Crystals; Johnson Insulators
Distributors RCA-DeForest Transmitting Tubes
Established 1914 *Send for Wholesale Catalog*

NEW YORK, NEW YORK

GROSS RADIO INC.
51 Vesey Street
"The Short Wave House"

PENNSYLVANIA, PHILADELPHIA

EUGENE G. WILE
10 South Tenth Street
Complete stock of high-grade radio apparatus

CHICAGO, ILLINOIS

Chicago Radio Apparatus Company, Inc.
415 South Dearborn Street
Harrison 2276
Dependable Radio Equipment
Established 1921
Bulletins on request.
Everything for the amateur.
Get our very low prices.

OAKLAND, CALIFORNIA

RADIO SUPPLY CO.
2085 BROADWAY
Hammarlund, Yaxley, Carter, National, Johnson, IRC, Cardwell, Miller, Morrill, Flechtheim, Triplett, Haigis Transceivers
W6GFY

MINNEAPOLIS, MINNESOTA

LEW BONN COMPANY
1124 Harmon Place
Rex L. Munger, W9LIP, Sales Manager
Radio Wholesaler Complete Stock

NEW YORK, N. Y. **227 FULTON ST.**

SUN RADIO CO.
Complete Stock of Amateur Radio Supplies at Wholesale Discounts

LOS ANGELES, CALIFORNIA

RADIO SUPPLY CO.
912 SO. BROADWAY
The Amateurs'
HEADQUARTERS of the WEST
All Nationally Advertised Parts for Receiving and Transmitting Carried in Stock at All Times.
9 Licensed Amateurs on Our Staff

The Marketplace

(a) Commercial rate: 10c per word, cash with order; minimum, $1.00. Capitals: 13c per word. For consecutive advertising, 15% discount for 3rd, 4th, and 5th insertions; 25% thereafter. Break in continuity restores full rate. Copy may be changed often as desired.

(b) Non-commercial rate: 5c per word, cash with order; minimum, 50c. Available only to licensed amateurs not trading for profit; our judgment as to character of advertisement must be accepted as final.

(c) Closing date (for classified forms only): 25th of month; e.g., forms for March issue, published in February, close January 25th.

(d) No display permitted except capitals.

(e) Used, reclaimed, defective, surplus, and like material must be so described.

(f) Ads not relating to radio or radiomen are acceptable but will be grouped separately.

(g) No commissions nor further discounts allowed. No proofs, free copies, nor reprints sent.

(h) Send all Marketplace ads direct to Los Angeles accompanied by remittance in full payable to the order of Radio, Ltd.

(i) We reserve the right to reject part or all of any ad without assigning reasons therefore. Rates and conditions are subject to change without notice.

THE BEST place to buy anything in radio, Palmer's Trading Post, Route One, Duluth, Minnesota. Trade in your old receiver for any make. Finest AT crystals $2.50, 80 and 160 band; "X"-cut, $1.65 for 80 and 160 band. 40 band, $2.00. 5C demonstrator, $62.50.

CRYSTAL blanks, y cut, 50c each. Good quartz. Postpaid. W9DGH.

REBUILT Vibroplexes $5 to $7. New large base bugs $9. Set tungsten contacts $2.50. Lydeard, 28 Circuit, Roxbury, Mass.

7000 kc. AT crystals at prices you can really afford—$3.00! Sonneborn's Crystal Laboratory, LaPorte, Indiana.

WANTED: Old spark equipment, step-up transformers, quenched gaps, mica condensers, Weston milliammeters, W5KD.

NEON TUBES, four inches, for RF testing, Oscilloscopes, special lengths made to order. Postpaid (U. S., Canada) $3.00. W8AXB, GLOMU SPECIALTIES, 3411 Harrison Avenue, Cheviot, Ohio, Dept. B.

QSL's, SWL's-Cards. Finest quality stock. Very attractive. Photo type. Different. Very reasonable. Samples? (Stamps). RADIO-PRESS-W8ESN, 1827 Cone St., Toledo, Ohio.

SELL or trade 200 watt rack and panel phone transmitter complete. Consider high class receiver or $125.00. W9GML.

SARGENT demonstrator model 10—8 tube super, 15-550 meters, with tubes, speaker. New guarantee. $39.00. Mack Radio, R. 5, Box 708, Stockton, Calif.

TRANSFORMERS: Power and modulation, filter chokes, etc., to order. Guaranteed 12 months. Reasonable. California Radio Laboratories, W6CYQ, 2523 So. Hill St., Los Angeles, Calif.

SEE October *R/9*, page 50, or November, page 61 for steel cabinets, racks. Many other sizes and types built. Write R. H. Lynch, 970 Camulos St., Los Angeles, Calif.

7000 kc. AT crystals guaranteed within 10 kc. $3.00. Sonneborn's Crystal Laboratory, LaPorte, Indiana.

THREE OF THE REASONS for the unusual accuracy and stability of the Micrometer Frequency Meter are:

- **The micrometer condenser—Isolantite insulated, of the cylinder and tube type. No flimsy plates.**
- **The temperature compensating condenser—practically eliminates errors due to changing temperature.**
- **The Isolantite coil form—permanent and ageless, no swelling or shrinking of coil dimensions.**

These three units available separately as a foundation unit. —Price, completely assembled, $21.00, postpaid for cash.

LAMPKIN LABORATORIES
BRADENTON, FLA.

OIL CONDENSERS, 2.75 mfd., 4000 volt working. Built to stand lightning surges. 50 lbs. List, $150; sell, $25 or trade. W6CVW.

CRYSTALS: SATISFACTION OR MONEY BACK. 160-80 meters within 10 kilocycles Y-cut $1. X-cut $1.35. Wright Laboratory, 5859 Glenwood, Chicago, Ill.

SELL: Emerson 500 v. m.g. set. Skyrider r.f. a.c. five, other equipment. List for stamp. Hosea Decker, Delaware, Ohio.

QSL SWL Cards, neat, attractive, reasonable. Samples free. Miller, Printer, Ambler, Pa.

METERS: New and used Weston, Jewell meters at bargain prices. All types, perfect condition, individually checked. Free bulletin. W2EDW, Far Rockaway, New York.

WHEN you don't know what to build it in, see R. H. Lynch, 970 Camulos, Los Angeles. Steel cabinets and racks, aluminum cans, panels. Special sizes to order. Send for circulars.

BLACK CRACKLE ENAMEL, air drying, half pint $.75. Primer for porus surfaces $.65. Coils for ACSW3, ACSW58, coverage $2.25, bandspread $2.50. LIQUID VICTRON COIL DOPE $.30. Radio Specialties, 433 Monroe, Brooklyn, N. Y.

WANTED: Edison storage "A" batteries, UX852s. Grote Reber, Wheaton, Illinois.

CAPITOL advanced radio course never used ($125). Sell $50 cash. Myron Kluge, 1041 No. Bonnie Brae, Los Angeles.

SW3 NATIONAL receiver, AC operaaed, tubes and 20, 80 and 160 coils. Best offer. Robertson, 608 North Gardner, Los Angeles.

MIGHTY MIDGET transmitter (original laboratory model) described in May, 1935 *R/9*. Perfect condition. Complete with X cut 80 meter crystal and coils, two Cardwell 380 μμfd. condensers for external Collins antenna coupler. Purchased with idea of becoming an amateur but never used. Money order for $27.50 takes it (this is less than wholesale cost of parts). Shipped by express. William Gin, 801 South Broadway, Santa Maria, California.

BACK COPIES of *R/9*: issues no. 37 to 48, 15c each; no. 50 to 59, 20c each; no. 60 to 73, 25c each; no. 74 and thereafter, 30c each. Money refunded on copies not available. 25% discount on 12 or more. Foreign, 5c per copy extra. *R/9*, 7460 Beverly Blvd., Los Angeles.

The Most Complete Callbook Ever Published

Your QRA is listed in the latest edition

The only radio callbook published that lists all radio amateur stations throughout the entire World.

Also a complete list of high frequency commercial stations, International abbreviations and amateur prefixes, "Q, R, & T," systems for reporting signals, new US inspection districts and high frequency time, press and weather schedules.

Each copy contains a double post card addressed to the CALLBOOK for use in reporting your new QRA. We are extremely anxious to publish a callbook that will be 100% correct and want you to help us by checking your QRA at once in the latest edition and advise us of any errors.

PUBLISHED QUARTERLY MARCH, JUNE, SEPTEMBER AND DECEMBER

Single Copies $1.25 Annual Subscription USA, $4.00

Order your copy today from your local radio jobber or direct from:

RADIO AMATEUR CALL BOOK, Inc.
606 South Dearborn Street, Chicago, Illinois

We're Overwhelmed—

Here's what they say about the SUPER SKYRIDER—

Marine Radio Co., Richmond Hill, N. Y., says: —
Sure is a honey stop completely sold out even samples stop double our order—

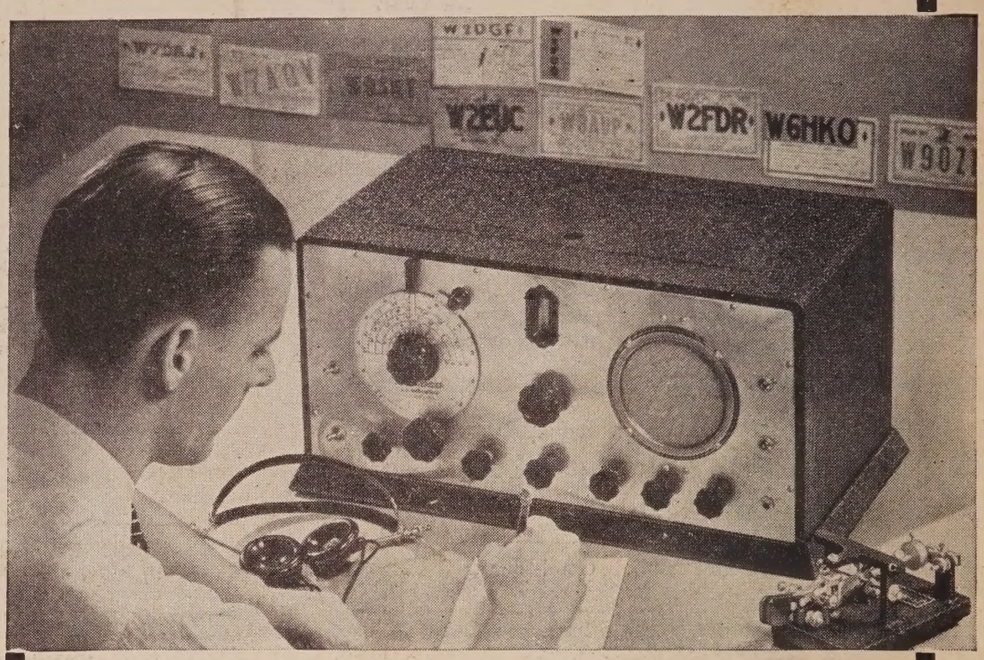
Radio Apparatus Corporation, Newark, N. J., says: —
Our customer's reaction to the appearance resulted in an enthusiasm exceeded only by the performance. We are positive that the Super Skyrider is not only the finest appearing receiver of the season but unquestionably the greatest performer.

Dow Radio Supply Co., Pasadena, Cal., says: —
Just received our order on the new Skyrider, and after a thorough tryout, I am indeed pleased and thrilled at its marvelous performance.

H. Pless Woodward, Statesville, N. C., says: —
I have received the new Skyrider and regard it as the outstanding value in radio today.

Gross Radio, Inc., New York, N. Y., says: —
Just went over your new Super Skyrider and must say I am certainly sold on this job. You seem to have outdone yourself.

Watkins Radio Service, St. Pierce, Fla.
Received the Super Skyrider today and find it really a masterpiece.

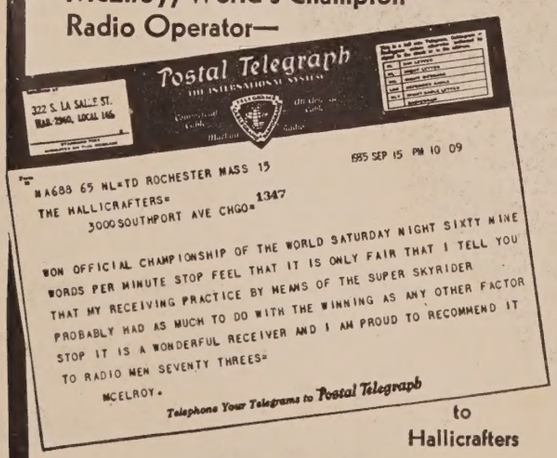


We knew the 1936 Super Skyrider was good, but the avalanche of enthusiastic approval has swept us off our feet. From all parts of the country, from dealers who handle all kinds of receivers and from hams who have used them, we've heard a chorus of unqualified praise and congratulations.

No wonder they're enthusiastic. The Super Skyrider has everything. It's sensitive beyond all practical requirements with its Iron Core I. F. system. The new Metal Tubes eliminate all tube shield noises and increase gain. It's convenient with its modern band changing system — no plug-in coils. A controlled Crystal Filter Circuit gives true one signal selectivity. These are but a few of the exclusive Hallicrafters features that have taken the short wave crowd by storm. You have to see the Super Skyrider to appreciate them all.

In spite of all its advantages and superlative Hallicrafters engineering, the Super Skyrider is extremely moderate in price. You needn't go broke for two years to get this fine short wave receiver. See it today.

McElroy, World's Champion Radio Operator—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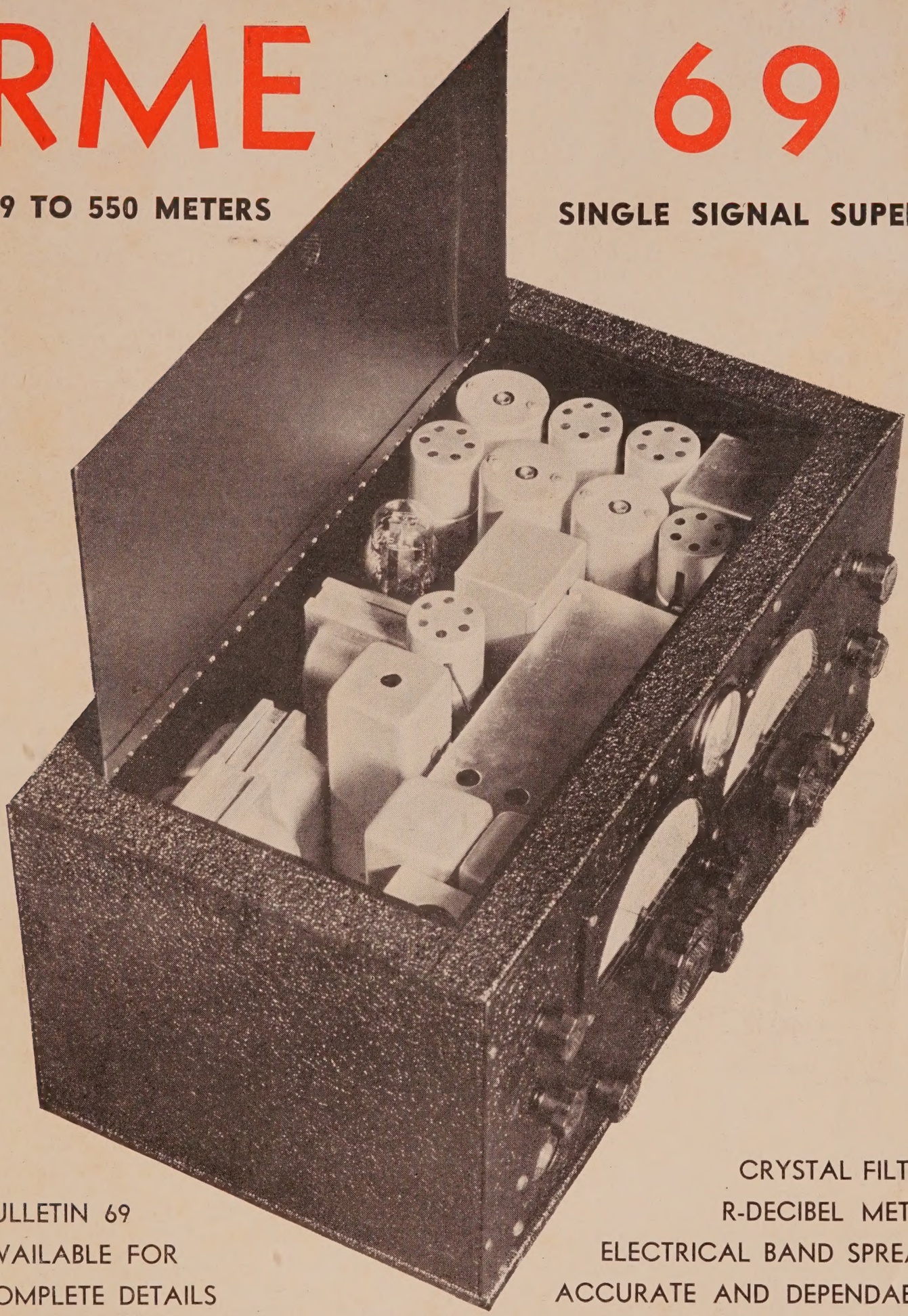

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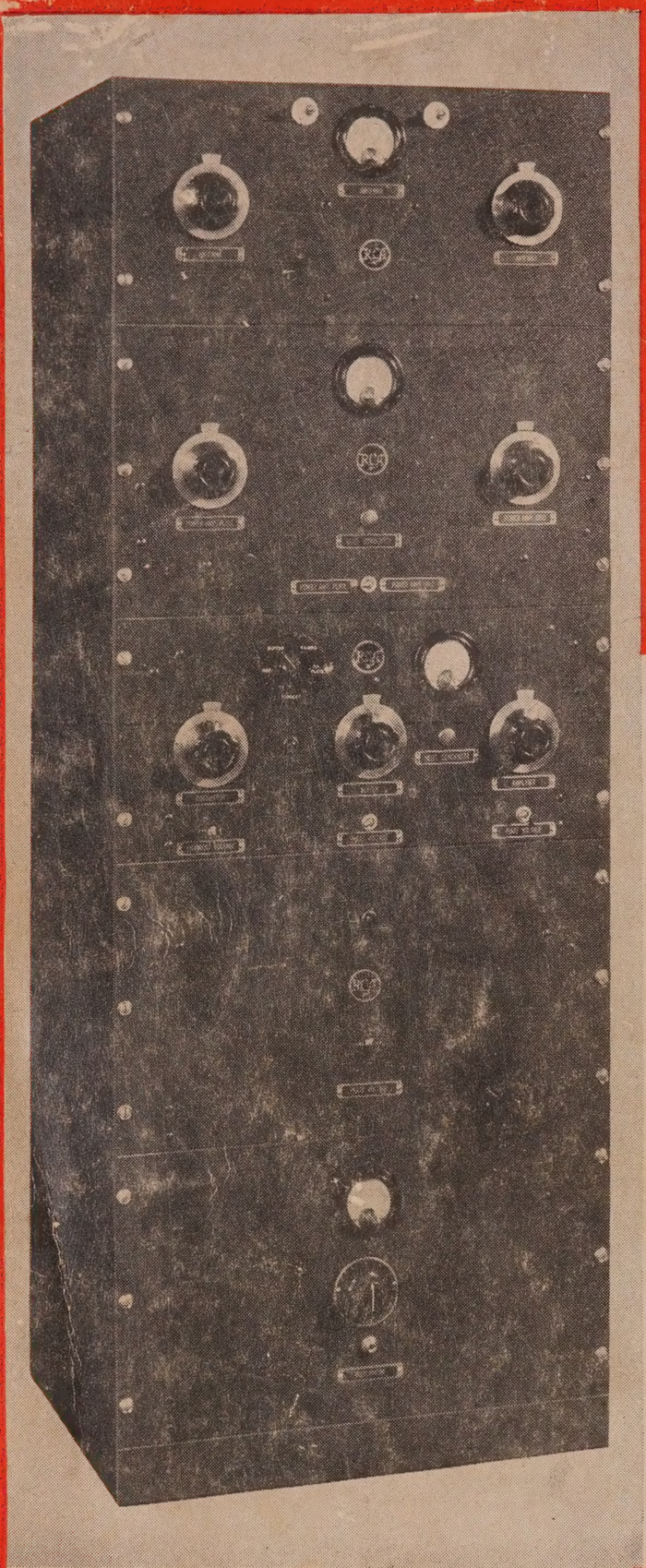

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